Lyndy J. McGaw
Muna Ali Abdalla *Editors*

Ethnoveterinary Medicine

Present and Future Concepts

Springer

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This book is dedicated to the memory of Dr. Luke F. Arnot (1970–2018).
An inspirational veterinary clinician, scientist, and educator, his energy and uncompromising dedication to the field of veterinary science will live on in those countless people and animals whose lives he influenced.

Contents

Author Biography

Lyndy J. McGaw is Associate Professor and Leader of the Phytomedicine Programme based at the Faculty of Veterinary Science, University of Pretoria. Her research focuses on investigation and development of effective and safe anthelmintic, acaricidal, anti-inflammatory, and antimicrobial remedies for use in animal and human medicine, as well as alternatives to antimicrobial feed additives.

She has published over 100 scientific papers and has contributed 14 book chapters. She serves on the editorial boards of *Frontiers in Ethnopharmacology*, *South African Journal of Botany*, *BMC Complementary and Alternative Medicine*, and *Journal of Ethnopharmacology*. She was listed as one of the top 31 cited African researchers in Pharmacology and Toxicology by Thomson Reuters in 2013 and was recently awarded "Researcher of the Year" at the Faculty of Veterinary Sciences, University of Pretoria.

Muna Ali Abdalla pursued her PhD studies in Natural Products Chemistry in the group of Prof. Hartmut Laatsch at Georg-August University of Göttingen, Germany. From February 2013 to January 2016, she worked as Alexander von Humboldt (AvH) Postdoctoral Fellow at the Institute of Chemistry, TU Berlin. From 2016, she was awarded a 3-year contract as a Senior Postdoctoral Fellow at the University of Pretoria, South Africa. She was appointed as a Phytochemist involved in collaborative projects as well as supervision of PhD students. She has published more than 30 papers in international peer-reviewed journals and discovered dozens of bioactive compounds such as abyssomicins, quinones, alkaloids, tetracyclopeptides, and phenolic compounds from microorganisms as well as several plant-derived metabolites.

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Chapter 1
Introduction

Muna Ali Abdalla and Lyndy J. McGaw

Keywords Global ethnoveterinary medicine · Documentation · Inventories · Pharmacological properties · Animal disease · Sociological aspects

1.1 Introduction

It is well documented that plant-derived secondary metabolites have been attracting the interest of researchers globally as alternative or complementary medications to synthetic agents. Research in the field of ethnoveterinary medicine is relatively neglected in comparison with research on traditional remedies for human ailments, but increasing attention is being focused on this aspect. In light of this, Chap. 2 discusses different natural products with pharmacological properties against animal diseases in addition to the effect of dietary plant natural products on animal performance. Chapter 2 indicates the promising pharmacological properties of plant-derived natural products against animal inflammatory diseases, bacterial and fungal infections as well as parasitic and viral diseases. Importantly, the authors in Chap. 3 report on 275 plant species used in different countries of the world to manage infectious ailments in animals. These medicinal plants have been used in parts of Africa such as South Africa and Uganda, as well as in other countries such as India, Pakistan, Nepal, Afghanistan, Pakistan, Brazil and Iran.

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Chapter 4 describes medicinal plants used for horses in British Columbia, Canada and Trinidad and Tobago. Different plants used to treat many horse diseases such as muscle soreness and tendon problems, injuries, coughs, colds and nosebleeds in addition to plants used as tonics are listed. Regarding the situation in Canada, products from two websites (Riva's Remedies and Greenhawk) have been used for horses in addition to ancient remedies, such as honey and cobwebs for wounds.

Chapter 5 discusses the potential of ethnoveterinary medicines for controlling parasites in goats. The authors report on plants used for both gastrointestinal parasitism and external parasitism. Conventional methods of controlling parasites and plant-derived ethnoveterinary medicaments for controlling parasites are mentioned. Additionally, indigenous plants known to have anthelmintic and acaricidal activities in South Africa are listed. In Chap. 6 ethnoveterinary practices for control of ticks in Africa are discussed extensively. The authors document information on the anti-tick ethnoveterinary practices in different parts of Africa, such as southern, East, West, Central and North Africa. Ethnoveterinary plants used against ticks in these regions are listed.

From general areas of interest in ethnoveterinary medicine, the focus of the book shifts to significant sociological issues in the second section. The authors of Chap. 7 introduce gender aspects and multiple contexts in ethnoveterinary practice and science. The cultural and ethical context of ethnoveterinary scientists and practices are considered. One of the authors (TvA) co-founded the Institute for Ethnobotany and Zoopharmacognosy (IEZ) in the Netherlands in 1995 as a private knowledge centre at a stage when there was no interest in phytotherapy research topics at universities in the Netherlands. The chapter as a whole illustrates how researchers at the IEZ work with animals and on environmental issues and how their work can contribute to Feminist Animal Studies (FAS) and Feminist Environmental Studies. It is significant in that it opens the door for new interdisciplinary collaborations, which are vital if we are to understand more about the traditions, cultures and other aspects of ethnoveterinary medicine.

The author of Chap. 8 writes from extensive experience in conducting field work in Africa and discusses difficulties in implementing practical applications of ethnoveterinary medicine in the continent. A holistic approach to medical matters and practical inputs deriving from functional interactions between traditional and Western medicine are recommended.

The third section of the book moves on to investigate in more detail ethnoveterinary medicine in various regions of the world. In Chap. 9 the authors review the use of traditional remedies for the treatment of livestock diseases in Cameroon, citing 138 plant species belonging to 110 genera and 69 families. Chapter 10 provides a summary of plants used in South African ethnoveterinary medicine. Further focus is placed on the ethnoveterinary plants as well as practices used more specifically in the control of ticks and tick-borne diseases in South Africa in Chap. 11. Traditional tick control methods in addition to the use of medicinal plants in South Africa are mentioned in this chapter. A Zimbabwean perspective of ethnoveterinary medicine is provided in Chap. 12, where interesting applications of complementary medicine and ethnoveterinary interventions in poultry care are reported. The authors also discuss ethnoveterinary practices in cattle and goats, as well as pharmacological activity of ethnomedicinal plants. Moving further north in Africa, Chap. 13 comprises a review of ethnoveterinary medicine in the Maghreb, a fascinating area of the world. Various types of practices including preventive and curative methods are documented, as are numerous plant species commonly used in Maghreb ethnoveterinary medicine.

Crossing to other parts of the world, natural remedies for animal health in Latin America are documented in Chap. 14. The authors report 364 plant species and 61 animal species used to treat diseases of livestock and herds in Latin America. Local practices of cattle raising and ethnoveterinary medicine in Estonia are reviewed in Chap. 15. This is the first report to provide a more thorough overview of the islands Saaremaa and Muhumaa in Estonia. The authors discuss the historic ethnoveterinary medicine, different herbs, mushrooms and mosses used against cattle illnesses in addition to non-herbal treatments in the area. Chapter 16 provides an enlightening discourse on the practices and methods used by Belarusian peasants to manage livestock diseases and preserve their health along with folk concepts and beliefs. In this chapter, charm-healing and Belarusian ethnoveterinary charms are documented, and plant and non-plant remedies used to treat livestock are mentioned. The use of plants for animal health care in the Spanish inventory of traditional knowledge is discussed in Chap. 17. The authors report on different remedies traditionally used in the treatment and prevention of many diseases of domestic animals, in addition to the importance of several plants used as fodder for livestock.

1.2 Conclusion

In providing chapters of general interest as well as those focusing on ethnoveterinary medicine in certain parts of the world in this book, it is hoped that the study of ethnoveterinary medicine will increase in prominence, involving multidisciplinary teams of researchers. It is clear that there is much work still to be done in this field and many lessons to be learned from all parts of the world.

Part I
The Role of Natural Products and Remedies in Treating Animal Diseases

Chapter 2
The Pharmacological and Nutritional Significance of Plant-Derived Natural Products: An Alternative for Animal Health

Muna Ali Abdalla and Lyndy J. McGaw

Keywords Antibiotic resistance · Animal performance · Fodder plants · Pasture · Beneficial nutrients · Nutritional supplementation

2.1 Introduction

The use of synthetic chemicals is harmful to our agricultural production systems, ecosystems and animal health. In that context there is a need for environmentally friendly practices in animal husbandry. To a great extent, grassland secondary metabolites may offer a significant approach to support livestock health (Poutaraud et al. 2017). This can be supported by evidence that grasslands and rangelands represent approximately two-thirds of global agricultural land (Leiber et al. 2014). It was reported that more than 40% of the total agricultural lands in Europe, including those in the Russian Federation, are meadows and pastures, which can be permanent or temporary grassland (FAOSTAT 2013). These agricultural lands represent around 50% of all livestock feedstuffs globally and are considered as the most important source of feed for domestic herbivores (Herrero et al. 2013). Plant natural products from permanent grasslands can contribute to limited pharmaceutical capacity and develop animal health. Due to their environmental and economic

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significance in low-cost animal feed, air and water quality, soil fertility, carbon sequestration, and flora and fauna conservation, the European Union promotes grassland maintenance (Michaud et al. 2015). Antibiotic resistance is now recognised as a major international issue across the world, and in that context the European Union has prohibited the use of antibiotics as growth promoters in farm animals since 2006 (Zeng et al. 2015). Consequently, this will increase the interest in naturally occurring plant secondary metabolites in animal diets (Acamovic and Brooker 2005).

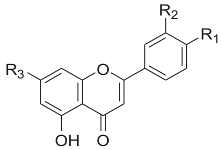
2.2 The Effect of Dietary Plant Natural Products on Animal Performance

Due to their high acceptability among consumers as natural feed additives, herbal feed additives are gaining interest as an alternative dietary strategy in animal nutrition. Plant natural products comprise groups of bioactive molecules such as flavonoids, tannins, glucosides, alkaloids, saponins, terpenoids, essential oils, amines, nonprotein amino acids and organosulfur compounds (Irchhaiya et al. 2015). A number of flavonoids have been isolated from different parts of alfalfa (Liang et al. 2011; Rafińska et al. 2017). The most important flavonoids of alfalfa (*Medicago sativa* L.) are listed in Fig. 2.1. Previous research reported that alfalfa flavonoid supplementation develops muscle oxidation stability through a lowering of thiobarbituric acid reactive substance (TBARS) values in a dose-related manner, when it was tested on growing rabbits to check their productive performances, carcass properties, meat quality and lipid oxidation. The study suggested that alfalfa supplementation is a good herbal additive to feed rabbits and has positive effects on qualitative properties of rabbit meat (Dabbou et al. 2018).

It has been reported that the promising antimicrobial activity of plant secondary metabolites is helpful in modifying the rumen microbial ecosystem to change fermentation and consequently inhibiting methane production. Essential oils, saponins and tannins are the three major plant natural products which showed greatest effectiveness in reducing methane production (Samal et al. 2016). It is important to note that the potential anthelmintic properties of particular grazing forages have gained much interest (Githiori et al. 2006).

It has also been reported that forages like *Lotus* spp., *Hedysarum* spp. (Aissa et al. 2016), *Onobrychis* spp. (Desrues et al. 2016) and *Cichorium intybus* (Peña-Espinoza et al. 2017) are rich in condensed tannins and other plant secondary metabolites. They have gained attention recently as potential candidates to control parasites in ruminant production systems if their consumption could be linked with good performance and anthelmintic impact.

In a previous study of the sheep nematode *Trichostrongylus colubriformis*, it was found that condensed tannins, extracted from *Lotus pedunculatus*, *Lotus corniculatus*, sainfoin (*Onobrychis viciifolia*) and *Hedysarum coronarium*, decreased



Flavonoid name	R_1	R_2	R_3
Apigenin 7-*O*-[*β*-D-glucurono-pyranosyl(1→2)-*O*-*β*-D-glucuro-nopyranosyl]-4'-*O*-*β*-D-glucuronopyranoside	-OGluA	-H	-OGluA(2→1) GluA
Apigenin 4'-*O*-*β*-D-glucuronopyranoside	-OGluA	-H	-OH
Apigenin 7-*O*-[*β*-D-glucuronopyranosyl(1→2)-*O*-*β*-D-glucuronopyranoside]	-OH	-H	-OGluA(2→1) GluA
Luteolin 7-*O*-*β*-D-glucurono-pyranoside	-OH	-OH	-OgluA
Apigenin 7-*O*-[2-*O*-feruloyl-*β*-D-glucuronopyranosyl(1→2)-*O*-*β*-D-glucuronopyranosyl]-4'-*O*-*β*-D-glucuronopyranoside	-OGluA	-H	-OGluA(2→1) GluA-2-*O*-Feruloyl
Apigenin 7-*O*-{2-*O*-feruloyl-[*β*-D-glucuronopyranosyl(1→3)]-*O*-*β*-D-glucuronopyranosyl(1→2)-*O*-*β*-D-glucuronopyranoside}	-OH	-H	-OGluA(2→1) GluA-[GluA(1→3)]- 2-*O*-Feruloyl
Apigenin 7-*O*-{2-*O*-*p*-coumaroyl-[*β*-D-glucuronopyranosyl (1→3)]-*O*-*β*-D-glucuronopyranosyl(1→2)-*O*-*β*-D-glucuronopyrano-side}	-OH	-H	-OGluA(2→1) GluA-[GluA(1→3)]-2-*O*-*p*-Coumaroyl
Apigenin 7-*O*-*β*-D-glucurono-pyranoside	-OH	-H	-OgluA
Luteolin 7-*O*-[2-feruloyl-*β*-D-glucuronopyranosyl(1→2)-*β*-D-glucuronopyranosyl]-4'b-*O*-*β*-D-glucuronopyranoside	-OGluA	-OH	-OGluA(2→1) GluA-2-*O*-Feruloyl

Fig. 2.1 Most important flavonoids of alfalfa (Stochmal et al. 2001)

the development of L1 larvae to L3 larvae and reduced the motility of L3 larvae when assessed by the inhibition assay of larval migration, and this might inhibit their infective capacity in vivo (Molan et al. 1999). Sheep feeding on *Hedysarum coronarium* (sulla) were found to have high performance and productivity, while carrying a substantial burden of *T. circumcincta* and *T. colubriformis* (Niezen et al. 1995), and they also had low levels of parasitism compared with sheep carrying a similar worm burden and fed on a low condensed tannin forage (*Medicago sativa*) (Robertson et al. 1995). Moreover, red deer feeding on *Cichorium intybus* showed lower lung and gastrointestinal worm burdens and high productivity, in comparison to deer grazing *Lolium perenne* (Hoskin et al. 1999). Additionally, *Cichorium intybus* showed anthelmintic effects against gastrointestinal nematode parasites in experimentally infected cattle (Peña-Espinoza et al. 2016).

2.3 Reported Plant Natural Products with Pharmacological Significance Against Animal Diseases

Plant secondary metabolites, which include a wide number of phytochemicals, are known as ingredients of the diets of humans and animals. They may have adverse effects on animals when ingested, which can be attributed to the chemistry of the molecules, the amount consumed, their concentration in the diet and the health status of the animals (Acamovic and Brooker 2005).

A number of medicinal plants and their component natural compounds have exhibited several pharmacological properties against animal diseases such as infections and inflammatory conditions. This has generated great interest and increased research regarding the use of phytochemicals and their effects in the diets of farm animals.

2.3.1 Animal Infectious Diseases

Infectious diseases of livestock are a potential threat to animal health and food safety, and their effective control is necessary for agronomic development, alleviating poverty in developing countries and in helping to improve food security (Tomley and Shirley 2009). Infectious diseases to which livestock are vulnerable are caused by pathogenic microorganisms, such as bacteria, fungi, viruses and parasites. They are classified into two major classes: endemic and exotic (Carslake et al. 2010). It is very important to note that the classification of a disease as exotic or endemic is actually a political decision to label a disease in a particular category. For example, foot-and-mouth disease (FMD) is exotic in the UK but was once endemic, and continues to be in many parts of the world (Carslake et al. 2010). Some notorious livestock diseases are endemic in many parts of the world, and pathogenic threats continue to emerge, re-emerge and persist. A number of factors such as global climate change, agronomical practices and demography present conditions that are likely to be favourable for the expansion of arthropod-borne diseases into new geographical regions. The prevalence of zoonotic infections, which are transmissible directly or indirectly (e.g. via arthropod vectors) between animals and humans, is a huge threat to human health. A topical example of the challenge represented by zoonotic viruses is the current pandemic status of new influenza A (H1N1) (Tomley and Shirley 2009; Mehrbod et al. 2018). It is important to mention that transmission of infectious diseases has a great effect on the poultry industry and causes potentially devastating threats to both humans and wild birds (Wang et al. 2013).

2.3.1.1 Parasitic Diseases

A number of scientific research studies on the antiparasitic activity of plant natural products have focused on the medicinal significance of plant natural products. The findings have led to the identification of active compounds, such as santonin (an anthelmintic drug from *Artemisia cina*) (Athanasiadou and Kyriazakis 2004). A study reported that helminths can be controlled by the use of plant natural products, particularly tannins (Williams et al. 2014a, b) such as tannin-containing legume forages such as sainfoin, *Sericea lespedeza* and some *Lotus* species (Hoste et al. 2012). Tannins might be responsible for the reduction of the worm fecundity, the ability of the host to reduce establishment of the larval population and the inhibition of the adult worm burden within the host. Some plant natural products have been found to be highly effective in controlling helminths when used as plant extracts (Athanasiadou et al. 2007).

A number of natural compounds with great structural diversity exhibited remarkable activity against a wide range of target parasites such as atanine (from *Evodia rutaecarpa*, Rutaceae) (Perrett and Whitfield 1995), eugenol (a component of essential oils of clove oil, nutmeg, cinnamon, basil and bay leaf) (Asha et al. 2001), palasonin (from *Butea monosperma*, Fabaceae) (Raj and Kurup 1968), alantalactone (from the roots of *Inula helenium* L. subsp. *turcoracemosa*) (Azouly et al. 1986; Gökbulut and Sarer 2013), tetra-hydroharmine (from *Banisteriopsis caapi*, Malpighiaceae), ascaridole (responsible for the flavour of the Chilean tree boldo and the main component of the oil of Mexican tea (wormseed)) (Efferth et al. 2002), azadirachtin, allicin (the main active component of garlic) (Velkers et al. 2011), kaurenoic acid (from *Annona senegalensis*, Annonaceae) (Mamidou Koné et al. 2005), etc.

These molecules can act as alternative drugs for the successful control of helminth parasites (Tariq 2018). Interestingly naturally occurring mixtures of the cysteine proteinases bromelain, papain and stem bromelain, which are found in *Papaya* latex, and the pure fruit preparations exhibited anthelmintic effects against two rodent cestodes, *Hymenolepis diminuta* and *Hymenolepis microstoma* in vitro (Mansur et al. 2014).

Tick invasion, which consequently leads to tick-borne diseases, causes huge problems for animal health. Almost 850 tick species and 30 major tick-borne diseases are known (Habeck 2002). *Hyalomma lusitanicum* is one of the most

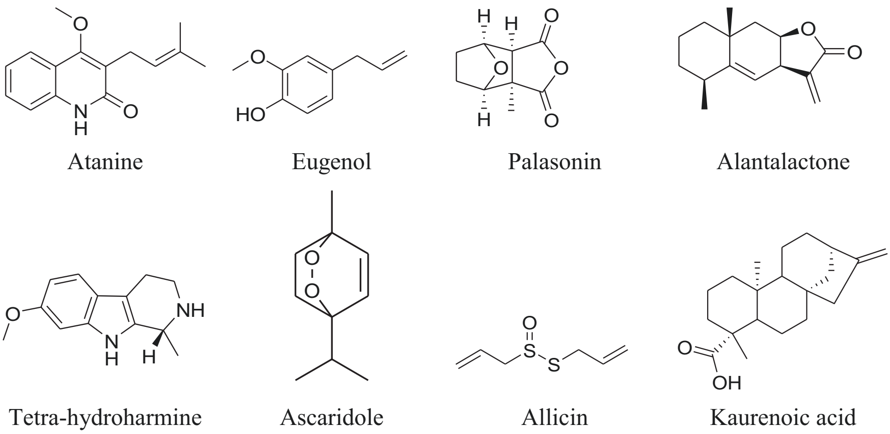
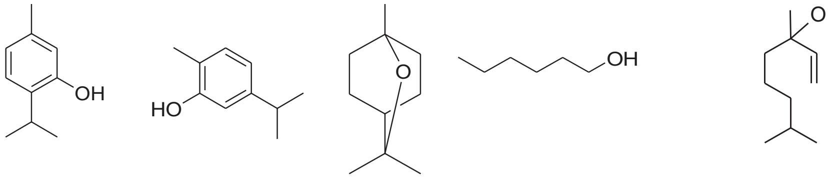


Fig. 2.2 Plant natural products with anthelmintic activity

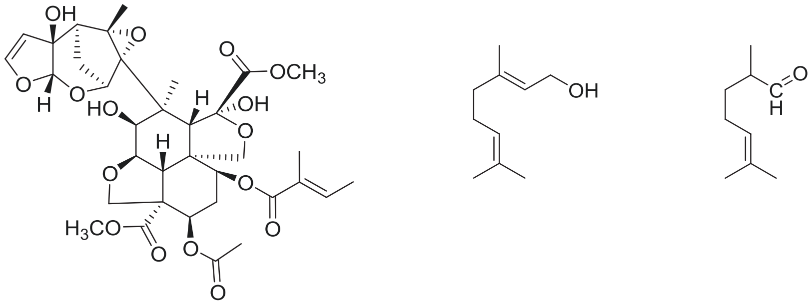
common species. Ticks can cause skin irritation and bacterial skin infections and affect the lymphatic system, which can consequently cause anaemia, fever, weight loss, lymph node swelling, milk drop, abortions and death (Habeck 2002). The ticks are mainly controlled using synthetic chemicals, which are administered to animals or their environment. However, these chemicals have consequently increased the development of resistance in these parasites and exhibited negative effects to the environment (Adenubi et al. 2018c).

In a recent study, plant species including those belonging to the Lamiaceae, Fabaceae, Asteraceae, Piperaceae, Verbenaceae and Poaceae families were evaluated for their acaricidal activity against *Rhipicephalus* (*Boophilus*), *Amblyomma*, *Dermacentor*, *Hyalomma* and *Argas* tick genera. Secondary metabolites, including thymol, carvacrol, 1,8-cineol and n-hexanal (as listed in Fig. 2.2), were found to be responsible for the acaricidal activity of the various essential oils against different species of ticks (Rosado-Aguilar et al. 2017).

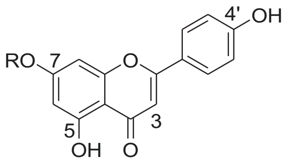
In a previous review, we evaluated 66 plant species, which were reported to control ticks based on their use by rural livestock farmers. These plants may be used as a potential source of acaricidal remedies as an extract or as a source of novel acaricidal candidates (Adenubi et al. 2016). In our recent review, extracts of some species such as *Azadirachta indica*, *Gynandropsis gynandra*, *Lavandula angustifolia*, *Pelargonium roseum* and *Cymbopogon* species showed promising acaricidal and larvicidal effects with 90–100% efficacy. Plant families with the highest acaricidal effect frequency were the Lamiaceae (25%), Asteraceae and Poaceae (10% each), Piperaceae (7.5%) and Verbenaceae, Solanaceae and Amaryllidaceae (5% each). The study discussed 26 isolated active molecules including azadirachtin, carvacrol, linalool, geraniol and citronellal (Adenubi et al. 2018a). Apigenin-7-O-*β*-D-glycoside and isorhoifolin were isolated from the chloroform fraction of *Calpurnia aurea* ethanol leaf extract, which exhibited good acaricidal activity. Isorhoifolin was not cytotoxic and showed potent activity (LC_{50} = 0.65 mg/ml) (Adenubi et al. 2018b) (Fig. 2.3).



Thymol Carvacrol 1,8-Cineol n-Hexanal Linalool



Azadirachtin Geraniol Citronellal



Flavonoids	R
Apigenin-7-*O*-β-D-glycoside	*β*-D-glucuronopyranose
Isorhoifolin	6″-α-L-rhamnopyranose-*β*-D-glucopyranose

Fig. 2.3 Plant natural products with acaricidal activity against different species of ticks

2.3.1.2 Bacterial and Fungal Infections

Important animal bacterial infectious diseases are anthrax, black quarter, diarrhoea, botulism (produced by the bacterium *Clostridium botulinum*), brucellosis, tuberculosis and pleuropneumonia (Chinsembu et al. 2014).

Anthrax is an infectious disease caused by a bacterium called *Bacillus anthracis* (Mwakapeje et al. 2018). It can affect several species of birds and is particularly important in herbivores, including sheep, cattle and goats (Himsworth 2008). It was reported previously that millions of livestock died from anthrax in Russia, Iran and South Africa (Beyer and Turnbull 2009). Humans can acquire anthrax directly from anthrax-infected animals or from anthrax-contaminated animal products (World Health Organization 2008; Fasanella et al. 2014). Antibiotics exhibiting weak efficacy in combating human and animal diseases through antibiotic resistance should be replaced with new drugs that can fight the burden of these microbial pathogens (National Strategy for Combating Antibiotic-Resistant Bacteria 2014; Abdalla and McGaw 2018a). Medicinal plants are known to be a highly promising source of a great number of drugs (Santos et al. 1995; Dwivedi and Wagay 2014). The discovery of antibacterial drugs from natural sources has revolutionised the treatment of many diseases in man and animals (Abdalla and Matasyoh 2014; Abdalla and McGaw 2018b). In a recent study, the extracts of nine medicinal plants showed remarkable antibacterial activity against *B. anthracis*. Interestingly the minimum inhibitory concentration values ranged from 0.02 to 0.31 mg/ml towards *B. anthracis* Sterne strain. The best MIC values were obtained with *Maesa lanceolata* (0.02 mg/ml), *Bolusanthus speciosus*, *Hypericum roeperianum*, *Morus mesozygia* (0.04 mg/ml) and *Pittosporum viridiflorum* (0.08 mg/ml). Additionally, the total antibacterial effect of the plant extracts was determined to be 92–5562 ml/g. Total activity is the extract from 1 g of the plant material that can be diluted and still inhibit activity against the microorganism. The medicinal plants *Maesa lanceolata* and *Hypericum roeperianum* delivered excellent total activity with values of 5562 and 2999 ml/g, respectively (Elisha et al. 2016).

Pathogenic fungi or mycoses have not been widely known to pose particularly high risks to global animal health. This understanding is changing due to the occurrence of various rapid declines in wildlife caused by the development of previously unknown fungi (Daszak et al. 2000; Smith et al. 2006; Fisher et al. 2012). Mycotic diseases are responsible for economic losses in the poultry industry because of direct infection or due to the production of mycotoxins (Dhama et al. 2013). Aspergillosis (mainly caused by *Aspergillus fumigatus*) is recognised as brooder's pneumonia and is known as the most pathogenic fungus affecting poultry (Arne et al. 2011). Alleviating diseases of infected animals requires long term drug administration which is a disadvantage in addition to its high cost. Plant derived antifungal molecules, particularly their application in topical therapy, might be considered as one of the attractive alternatives (Trakranrungsie 2011). Comprehensive lists of plants, extracts and isolated plant metabolites with antifungal activity have been published (Rai and Mares 2003; Rawat et al. 2008). Previous studies demonstrated that the amides and cinnamoyl derivatives, obtained from species of the family Piperaceae, could be responsible for their antimicrobial activities (Kun-anake 1998; Vasques da Silva et al. 2002).

The major constituents of *Piper betle* leaves were found to be terpenes and phenols (Bajpai et al. 2010). They showed promising antidermatophytic effects, and a 10% *P. betle* cream was formulated (Curtis 1998). Its antidermatophytic activity was effective up to 96 h after incubation compared to that of ketoconazole cream (Trakranrungsie et al. 2004). Additionally, the ointment and gel formulations containing 4% of *P. betle* extracts exhibited high antifungal activity similar to clotrimazole cream (1%), but more than tolnaftate cream (1%). The mentioned preparations decreased rash and irritation before or after UV irradiation in rabbit and guinea pig toxicity tests (Boonrattanakornki et al. 1990). On the other hand, the *P. betle* preparation was less stable and lost its activity rapidly.

2.3.1.3 Viral Diseases

Zoonotic infections feature strongly among the wide range of human diseases encountered, including anthrax, tuberculosis, plague, yellow fever and influenza, which may be transmitted from domestic animals, poultry and livestock. Additionally, climate change conditions and human behaviour and habitat will likely result in increased infections from wildlife species (Wang and Crameri 2014). Medicinal plants have been known as potential sources of antiviral agents for decades. Although it has been reported that few studies search for antiviral agents from medicinal plants, these studies have detected the presence of promising antiviral activity in plants. Almost 20–30% of plants from tropical or temperate areas were shown to have antiviral activity. It has been found that a number of molecules of different classes isolated from medicinal plants have antiviral activity (Perez 2003). The crude alcoholic extract of the seed of *Nyctanthes arbortristis* (Verbenaceae) showed antiviral activity, and the isolated iridoid glucosides, known as arbotristosides A, B and C (Fig. 2.4), were also significantly active against encephalomyocarditis virus (EMCV) and Semliki Forest virus (SFV) with an increase in average survival time of the infected animals (Rathore et al. 1990).

Foot-and-mouth disease which is caused by Aphthovirus of family Picornaviridae, and sometimes known as a fatal viral disease, affects cloven-footed animals, such as sheep, cattle, pigs, goats, llamas and deer, in addition to wild bovids. A number of traditionally used medicinal plants in India were applied for the treatment of animal foot-and-mouth disease such as *Andrographis paniculata* (Burm.f.) Nees (kirayat) (family Acanthaceae), *Colocasia esculenta* (L.) Schott (Arvi) (family Araceae) (Panda and Dhal 2014; Mishra et al. 2015), *Cuscuta reflexa* Roxb. (Amar Bel) (family Cuscutaceae) (Malla and Chhetri 2012), *Carissa caranta* L. (Garanda) (family Apocynaceae) (Khan et al. 2012) and *Calotropis gigantea* (L.) R.Br. (Safed aak) (family Asclepiadaceae) (Rao et al. 2014).

2.3.1.4 Inflammatory Diseases

Inflammatory bowel disease (IBD) is a chronic and disrupted inflammation of the intestinal tract that is a common cause of chronic gastrointestinal upset in dogs and cats (Callahan 2018). IBD has two principal types named as ulcerative colitis (UC)

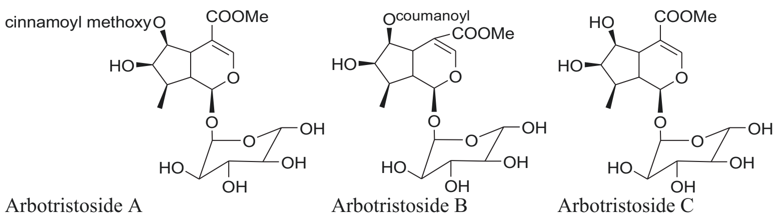


Fig. 2.4 The antiviral arbotristosides A, B and C

and Crohn's disease (CD) (Hendrickson et al. 2002). It is also associated with chronic inflammation of the intestinal tract (IT) (Shah et al. 2007). Clinical signs such as changes in appetite, vomiting, diarrhoea and weight loss are the most common inflammatory conditions caused by IBD (Goyal et al. 2014). Several plant secondary metabolites exhibited potent antioxidant activities as modulators in the expression and activity of antioxidant enzymes and as free radical scavengers. A number of plant natural molecules were proven to suppress the release of pro-inflammatory cytokines, inhibiting the activation of nuclear factor κB (NF-κB), which is necessary for the inflammatory response in inflammatory bowel disease (Alves de Almeida et al. 2017).

Plant secondary metabolites are a potential source of immune modulators, antioxidants and anti-inflammatory agents (Gautam and Jachak 2009; Iqbal et al. 2013; Debnath et al. 2013; Motlhatlego et al. 2018). In a previous report, 32 alkaloids were found to induce the disruption of the epithelial barrier (dextran sulphate sodium (DSS), acetic acid or mustard oil) in intestinal inflammation (TNBS) in experimental models, mainly in mice. Among these alkaloids, the effects of piperine, berberine and sinomenine on experimental colitis were discussed (Alves de Almeida et al. 2017). The alkaloid piperine (from *Piper nigrum* and *Piper longum*, Piperaceae) was known for its anti-inflammatory effects (Diwan et al. 2011). It was proven to enhance the absorption and pharmacological activity of the herbal supplement curcumin (*Curcuma longa*, Zingiberaceae). A nanoformulation encapsulating piperine and curcumin, called self-microemulsifying drug delivery system (CUR-PIP-SMEDDS), was developed. The system CUR-PIP-SMEDDS enhanced the drug stability and in vitro dissolution of curcumin at the colon site. This showed its therapeutic impact in DSS-induced colitis in mice. The system CUR-PIP-SMEDDS inhibits disease activity index (DAI), histopathological lesions, myeloperoxidase (MPO) activity, MDA content, tumour necrosis factor (TNF-α) and interleukin 6 (IL-6) levels in colonic tissues of mice (Li et al. 2015). Piperine treatment was found to ameliorate body weight loss, histological injury, diarrhoea and the expression of inflammatory mediators on DSS-induced colitis in mice. When the pregnane X receptor (PXR) was downregulated, the DSS injury was exacerbated and piperine protection against DSS colitis was inhibited (Hu et al. 2015).

A natural supplement berberine (from *Berberis*, *Hydrastis*, *Coptis* and *Phellodendron* species) (Tillhon et al. 2012) possesses potent pharmacological activity in intestinal inflammatory models (Mokhber-Dezfuli et al. 2014). Berberine was found to inhibit colonic inflammation in UC and CD experimental models and decreased release of cytokines (TNF-α, IL-1β, IL-6, IL-12 and IL17). It was also shown to alleviate DSS-induced colitis by ameliorating intestinal barrier function and decreasing inflammation and oxidative stress (Zhang et al. 2017). It was also investigated in various clinical trials and found to reduce symptoms of many diseases such as non-alcoholic fatty liver disease (Chen et al. 2015), acute coronary syndrome inflammation (Newman and Cragg 2012) and irritable bowel syndrome (Baker et al. 2007) without any side effects.

Sinomenine activity was reported in experimental colitis (Cheng et al. 2007; Yu et al. 2013). It reduced the generation of inflammatory mediators in TNBS-induced

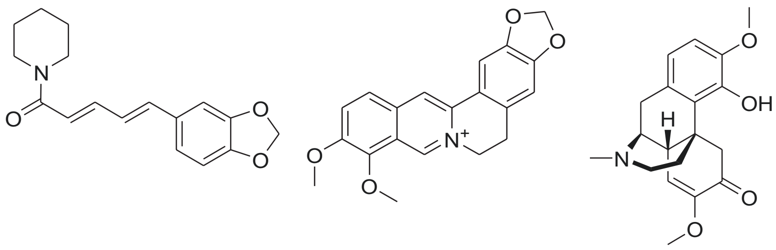


Fig. 2.5 Plant natural products with pharmacological anti-inflammatory effects

colitis in mice. It was discovered to downregulate the transcription factor c-Maf, microRNA 155 (MiR-155) and the cytokines TNF-α and IFN-γ. Sinomenine exhibited analgesic effects on neuropathic and inflammatory pain models (Gao et al. 2013) in addition to suppressive activity on colon carcinoma cell growth (Zhang et al. 2014; Liu et al. 2014) and anti-inflammatory effects (Wang and Li 2011) (Fig. 2.5).

2.4 Conclusion and Future Prospects

The growing trend of zoonotic disease emergence in the last few decades emphasises the important role that the One Health strategy plays in the aspects of investigation, control and prevention. This has established the beginning of the One Health era.

Research on plant natural product-containing fodder plants and other plant extracts is ongoing and becoming an interesting field worldwide, with a lot of potential for the control of many animal infectious diseases such as animal parasites, including ticks and helminths.

The dietary contribution of plant natural products has a huge role on animal performance and health status, so producing food with a high nutritional value and sufficient concentrations of antioxidants, vitamins and functional fatty acids is important. This can be done by expanding growth of forages rich in plant secondary metabolites. Other factors should be taken into account such as maintaining animal requirements, spatial grazing and management of pasture, as well as increasing the forage yield and quality, and providing a healthier place for livestock.

Owing to the growing trend in awareness of ethnoveterinary medicine, plant-derived natural products have been attracting the interest of scientists globally as alternatives to synthetic agents. In this regard in vivo studies and experiments in animal models are needed to confirm the discovered bioactivities of the extracts of medicinal plants and the isolated molecules to identify novel medicinal remedies.

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Chapter 3
Alternative Antimicrobials: Medicinal Plants and Their Influences on Animal Infectious Diseases

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Keywords Antibiotics · Phytoconstituents · Zoopharmacognosy · Medicinal plants · Africa

3.1 Introduction

Ethnoveterinary medicine refers to the beliefs, knowledge, methods, practices and techniques used in the promotion of healthcare and well-being among animals as described by Barboza et al. (2007). The use of traditional medicine, particularly phytotherapy, to promote animal health is not a new practice and forms part of the early traditional practices performed worldwide due to their easy availability, effectiveness and low cost and this practice has been transferred between generations (McGaw et al. 2007). Indeed, the use of plants has been of major influence in the prophylaxis and treatment of diverse infectious disorders in animals, for example, against parasites, intestinal worms, conjunctivitis and heartwater alongside other ailments (Table 3.1).

Notably, this practice has received due attention in the West during recent years due to a mounting number of failing antibiotics. Interestingly, a plethora of ethnoveterinary studies have been published in various parts of the world during the previous years as in Africa (Gradé et al. 2009; Moreki et al. 2010; Opiro et al. 2010; Gakuya et al. 2011); America (Jernigan 2009; Monteiro et al. 2011) and Asia (Galav et al. 2010; Dilshad et al. 2010; Raziq et al. 2010; Phondani et al. 2010) and other countries as well (Benítez et al. 2012). Knowledge pertaining to ethnoveterinary practices is consolidated in many parts as a large proportion of the world's population still rely on livestock rearing as a source of income and food and employ plants and their corresponding preparations to treat animal ailment conditions.

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Table 3.1 Plants used as antimicrobial agents in different regions of the world

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
1	*Abutilon indicum* G. Don.	Malvaceae	India	Leaf, fruit	Dysentery, diarrhoea	Oral	Parthiban et al. (2016)
2	*Acacia karroo* Hayne	Fabaceae	South Africa	Bark, leaves	Diarrhoea in goats, intestinal parasites in goats, sheep, poultry and pigs fractures and diarrhoea	Oral	Dold and Cocks (2001), Van der Merwe et al. (2001)
3	*Acacia nilotica* (L.) Delile	Fabaceae	Uganda	Bark (water extract)	Pneumonia	Oral	Gradé et al. (2009)
4	*Acacia oerfota* (Forssk.) Schweinf.	Fabaceae	Uganda	Bark (water extract)	Pneumonia	Oral	Gradé et al. (2009)
5	*Acacia* sp.	Fabaceae	Uganda	Fruit	Goat pox	Oral	Gradé et al. (2009)
6	*Acacia tortilis* (Forssk.) Hayne	Fabaceae	South Africa	Branch tips	Diarrhoea	Oral	Van der Merwe et al. (2001)
7	*Acalypha fruticosa* Forssk.	Euphorbiaceae	Uganda	Root	Pneumonia	Oral	Gradé et al. (2009)
8	*Achyranthes aspera* L.	Amaranthaceae	India	Leaf	Conjunctivitis	Topical	Nag et al. (2007)
9	*Acmella caulirhiza* Delile	Asteraceae	Uganda	Root	Pneumonia	Oral	Gradé et al. (2009)
10	*Aconitum heterophyllum* Wall. Ex Royle	Ranunculaceae	India (Uttarakhand)		Intestinal worm, fever	Oral	Pande et al. (2007)
11	*Adhatoda vasica* Nees.	Acanthaceae	India	Leaf, bark	Cough; diarrhoea; dysentery	Oral	Parthiban et al. (2016)
12	*Adiantum capillus-veneris* L.	Adiantaceae	India	Leaf, stem	Cough	Oral	Sehgal and Sood (2013)
13	*Aeollanthus* sp.	Lamiaceae	Uganda	Root	Trypanosomiases	Oral	Gradé et al. (2009)
14	*Agapanthus praecox* Willd.	Alliaceae	South Africa	Roots	Diarrhoea in sheep and goats	Oral	Dold and Cocks (2001)

15	*Aizoon canariense* L.	Aizoaceae	Pakistan	Aerial	Myiasis	Topical	Farooq et al. (2008)
16	*Albizia anthelmintica* Brongn.	Fabaceae	Uganda	Bark	Anthelmintic	Oral	Gradé et al. (2009)
17	*Albizia coriaria* Welw. ex Oliv.	Fabaceae	Uganda	Bark	Pneumonia	Oral	Gradé et al. (2009)
					Pleuropneumonia		
					Fever		
18	*Albizia lebbeck* (Linn.) Benth.	Mimosaceae	India	Seeds	Eye infection	Topical	Sharma et al. (2012)
19	*Albizia zygia* (DC) J.F. Macbr.	Fabaceae	Uganda	Bark	Mange	Oral	Gradé et al. (2009)
20	*Allium cepa* L.	Alliaceae	Uganda	Root	Anaplasmosis	Oral	Gradé et al. (2009)
21	*Allium sativum* L.	Alliaceae	India; Pakistan; Sri Lanka	Bulb	Cough; mastitis	Oral; topical	Ganesan et al. (2008), Ul Haq et al. (2011), Nair and Punniamurthy (2016), Dilshad et al. (2010)
22	*Aloe dawei* Berger	Asphodelaceae	Uganda	Leaf	Anaplasmosis	Oral	Gradé et al. (2009)
23	*Aloe ferox* Mill.	Asphodelaceae	South Africa	Leaves	Juices from leaves	Oral	Dold and Cocks (2001), Masika et al. (2000)
					Typhoid, ticks and lice in poultry, redwater in cattle; redwater, intestinal worms		
24	*Aloe greatheadii* var. davyana (Schönland) H.F.Glen & D.S.Hardy	Asphodelaceae	South Africa	Leaves, roots, whole plant	Eye infections	Topical	Van der Merwe et al. (2001)
25	*Aloe marlothii* Berger	Asphodelaceae	South Africa	Leaves	Newcastle disease in chickens, gall sickness, parasites, diarrhoea, constipation, retained placenta, dystocia, maggots	Oral	Luseba and Van der Merwe (2006), Van der Merwe et al. (2001)

(continued)

Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
26	*Aloe* sp.	Asphodelaceae	Uganda	Leaf	Pleuropneumonia	Oral	Gradé et al. (2009)
27	*Aloe* sp.	Asphodelaceae	Uganda	Leaf	Fever	Oral	Gradé et al. (2009)
28	*Aloe tenuior* Haw.	Asphodelaceae	South Africa	Leaves	Retained placenta in cows, tapeworm, redwater, intestinal parasites	Oral	Dold and Cocks (2001)
29	*Aloe tweediae* Christian	Asphodelaceae	Uganda	Leaf	Anaplasmosis	Oral	Gradé et al. (2009)
					Fever		
					Pleuropneumonia		
30	*Aloe zebrine* Baker	Asphodelaceae	South Africa	Fresh leaves, roots, whole plant	Wounds and maggots; burns, general ailments, blood cleansing, internal parasites, eye infections	Oral	Luseba and Van der Merwe, (2006), Van der Merwe et al. (2001)
31	*Amaranthus spinosus* L.	Amaranthaceae	Bangladesh	Whole plant	Gastrointestinal worms	Oral	Sujon et al. (2008)
32	*Amaranthus viridis* L.	Amaranthaceae	Pakistan	Leaves and seeds	Malarial fever	Oral	Ahmed and Murtaza (2015)
33	*Amygdalus arabica*	Rosaceae	Iran	Fruit	Tick, lice, intestinal worms	Oral	Pirbalouti et al. (2009)
34	*Anacardium giganteum* W. Hancock ex Engl.	Anacardiaceae	Brazil	Bark	Mange	Oral	Ritter et al. (2012)
35	*Ananas comosus* (L.) Merr.	Bromeliaceae	India; Pakistan; Bangladesh; Brazil	Fruit	Endoparasites	Oral	Sujon et al. (2008), Githiori et al. (2004), Ul Haq et al. (2011), Ritter et al. (2012)
					Anthelmintic		
36	*Andrographis serpyllifolia* (Vahl) Wight	Acanthaceae	Sri Lanka	Leaf; root	Mastitis	Topical	Nair and Punniamurthy (2016)
37	*Anogeissus latifolia* Wall. ex Guill. & Perr.	Combretaceae	India	Bark	Ephemeral	Oral	Upadhyay et al. (2011)
					Fever		

38	*Annona mucosa* Jacq.	Annonaceae	Brazil	Exudate	Anthelmintic	Oral	Ritter et al. (2012)
39	*Aquilegia pubiflora* Wall. ex Royle	Ranunculaceae	Pakistan	Aerial	Anthelmintic	Oral	Ahmed and Murtaza (2015)
40	*Arisaema jacquemontii* Blume	Amaranthaceae	Pakistan	Whole plant	Cholera, flu, dysentery, dyspepsia and inflammation of gut and snake bite	Oral	Ahmed and Murtaza (2015)
41	*Arisaema flavum* (Forssk.) Schoot	Araceae	Pakistan	Leaf	Mouth and foot diseases of cattle	Oral	Ahmed and Murtaza (2015)
42	*Artemisia herba-alba*	Compositae	Iran	Aerial part	Anthelmintic	Oral	Pirbalouti et al. (2009)
43	*Artemisia kermanensis* PodI.	Asteraceae	Kerman (Iran)	Aerial part	Anti-candida	Oral	Pirbalouti et al. (2009)
44	*Artemisia nilagirica* (C.B. Clarke) Pamp.	Asteraceae	India	Leaf	Anthelmintic, lice	Oral, topical	Sharma et al. (2012)
45	*Aspilia mossambicensis* (Oliv.) Wild	Asteraceae	Uganda	Fruit, root	Anaplasmosis	Oral	Gradé et al. (2009)
46	*Azadirachta indica* A. Juss.	Meliaceae	Bangladesh; India; Pakistan; Uganda	Leaf, bark, root	Ecto-/endoparasites	Topical/oral	Abbasi et al. (2013), Sujon et al. (2008)
					Fever		
					Mange		
					Ringworm		
47	*Bactris gasipaes* Kunth.	Arecaceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
48	*Balanites aegyptiacus* (L.) Delile	Zygophyllaceae	Uganda	Exudate	Heartwater	Oral	Gradé et al. (2009)
49	*Bixa orellana* L.	Bixaceae	Brazil	Leaf	Mange	Oral	Ritter et al. (2012)
50	*Bambusa arundinacea* Willd.	Poaceae	India	Leaf; stem	Anthelmintic	Oral	Sharma et al. (2012)
51	*Bauhinia racemose* Lam.	Caesalpiniaceae	India	Whole plant	Leucorrhoea	Oral	Upadhyay et al. (2011)

(continued)

Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
52	*Bauhinia variegata* L.	Leguminosae	India; Pakistan	Flower	Diarrhoea; mouth disease	Oral	Khan and Hanif (2006), Pande et al. (2007), Bharati and Sharma (2010), Sehgal and Sood (2013)
53	*Berberis chitria* Edwards	Berberidaceae	India (Uttarakhand)		Conjunctivitis	Topical	Pande et al. (2007)
54	*Berberis petiolaris* Wall. ex G. Don.	Berberidaceae	India (Uttarakhand)		Conjunctivitis	Topical	Pande et al. (2007)
	Bergenia ciliata (Royle) Raizada		India (Uttarakhand)		Anthelmintic	Oral	Pande et al. (2007)
56	*Berberis vulgaris* L.	Berberidaceae	Afghanistan	Root; bark	Gastrointestinal parasites; cough	Oral	Davis et al. (1995)
57	*Berchemia zeyheri* (Sond.) Grubov	Rhamnaceae	South Africa		Infectious diseases in cattle	Oral	Hutchings et al. (1996)
58	*Bidens pilosa* L.	Asteraceae	South Africa	Unspecified	Equine anthelmintics	Oral	Hutchings et al. (1996)
59	*Bulbine alooides* (L.) Willd.	Asphodelaceae	South Africa	Root	Redwater in cattle	Oral	Dold and Cocks (2001)
60	*Brassica campestris* L.	Brassicaceae	India; Pakistan	Leaf; seed	Wounds; mastitis	Topical	Sehgal and Sood (2013), Abbasi et al. (2013), Farooq (2008), Dilshad et al. (2010), Pande et al. (2007), Farah (2009)
61	*Brassica juncea* (L.) Hook.f. & Thomson	Brassicaceae	India	Leaf; seed	Intestinal worms	Oral	Sehgal and Sood (2013)

62	*Brachylaena discolor* DC.	Asteraceae	South Africa	Dried leaf milk infusions	Anthelmintics for calves, sheep and goats	Oral	Hutchings et al. (1996)
63	*Bromelia* sp.	Bromeliaceae	Brazil	Canine	Anthelmintic	Oral	Ritter et al. (2012)
64	*Butyrospermum paradoxum* C.F. Gaertn Hepper	Sapotaceae	Uganda	Seed oil	Mange	Oral	Gradé et al. (2009)
65	*Calotropis procera* (Aiton) W.T. Aiton	Apocynaceae	Uganda	Whole plant	East Coast fever, anaplasmosis	Oral	Gradé et al. (2009)
66	*Capparis fascicularis* DC. var. elaeagnoides (Gilg) DeWolf	Capparaceae	Uganda	Bark	Heartwater	Oral	Gradé et al. (2009)
67	*Capparis tomentosa* Lam.	Capparaceae	Uganda	Root	Heartwater, anaplasmosis	Oral	Gradé et al. (2009)
68	*Capparis* sp.	Capparaceae	Uganda	Bark	Anaplasmosis, fever, pleuropneumonia	Oral	Gradé et al. (2009)
69	*Capsicum annuum* L.	Solanaceae	Pakistan	Fruit	Helminthiasis, anaplasmosis, pleuropneumonia, heartwater	Oral	Farooq et al. (2008)
70	*Carica papaya* L.	Caricaceae	Uganda	Seeds	Intestinal parasites	Oral	Gradé et al. (2009)
			Brazil	Canine	Anthelmintic		
71	*Carissa spinarum* L.	Apocynaceae	Uganda	Root	Anaplasmosis, pleuropneumonia, chicken pox, East Coast fever, heartwater	Oral	Gradé et al. (2009)
72	*Casearia esculenta* Roxb	Samydaceae	India	Stem	Trypanosomiasis	Oral	Upadhyay et al. (2011)
73	*Cassia abbreviata* Oliv.	Fabaceae	South Africa	Bark	Drench for worm infestations	Oral	Luseba and Van der Merwe (2006)
74	*Cassine aethiopica* Thunb.	Celastraceae	South Africa	Milk or whey bark infusion	Used by Zulus to drench worm-infested calves	Oral	Watt and Breyer-Brandwijk (1962)

(continued)

Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
75	*Cassia nigricans* Vahl	Fabaceae	Uganda	Leaf	Fever, intestinal parasites, meningitis	Oral	Gradé et al. (2009)
76	*Cassytha filiformis* L.	Lauraceae	India	Twigs	Liver fluke infestation	Oral	Upadhyay et al. (2011)
77	*Cedrus deodara* (Roxb. ex D.Don) G. Don	Pinaceae	India	Stem	Foot, mouth disease and broken horn	Topical	Sharma et al. (2012)
78	*Cedrus libani* A. Rich.	Pinaceae	Afghanistan	Resin; wood oil	Ectoparasites; cough	Topical; oral	Davis et al. (1995)
79	*Centella asiatica* (L.) Urban	Apiaceae	India (Uttarakhand)		Fever	Oral	Pande et al. (2007)
80	*Cerasus microcarpa* (C. A. Mey.) Boiss.	Rosaceae	Iran	Leaf	Antiseptic and disinfection of wounds	Topical	Pirbalouti et al. (2009)
81	*Chasmanthera dependens* Hochst.	Menispermaceae	Uganda	Root	Anaplasmosis, East Coast fever, fever	Oral	Gradé et al. (2009)
82	*Chelonanthus alatus* (Aubl.) Pulle.	Gentianaceae	Brazil	Leaf	Mange	Oral	Ritter et al. (2012)
83	*Chenopodium ambrosioides* L.	Amaranthaceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
84	*Chloroxylon swietenia* DC	Flindersiaceae	India	Bark	Anthrax	Oral	Upadhyay et al. (2011)
85	*Cissus quadrangularis* L.	Vitaceae	India; Uganda	Leaf	Fever, anaplasmosis, pleuropneumonia, intestinal parasites	Oral	Parthiban et al. (2016), Gradé et al. (2009)
86	*Citrullus colocynthis*	Cucurbitaceae	Iran	Fruit and flower	Antiseptic and wound healing	Topical	Pirbalouti et al. (2009)
87	*Citrus X limon* (L.) Osbeck.	Rutaceae	Brazil	Fruit	Mange	Oral	Ritter et al. (2012)

88	*Clematis brachiata* Thunb.	Ranunculaceae	South Africa	Infusions from shoots and leaves	Vermifuge and for bots in horses	Oral	Hutchings et al. (1996)
89	*Clerodendrum glabrum* E.Mey.	Verbenaceae	South Africa	Leaves, bark	Unspecified parts are used as purgatives for calves. The Sotho and Swazi use topical leaf decoctions to prevent parasites developing in animal wounds. The Tswana use leaf infusions and bark scrapings as anthelmintics for dogs, calves and donkeys	Oral	Hutchings et al. (1996), Watt and Breyer-Brandwijk (1962), Roberts (1990)
90	*Clibadium surinamense* L.	Asteraceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
91	*Clidemia capitellata* (Bonpl.) D. Don.	Melastomataceae	Brazil	Leaf	Mange	Oral	Ritter et al. (2012)
92	*Cocculus hirsutus* (L.) Theob.	Menispermaceae	India	Whole plant	Diarrhoea	Oral	Upadhyay et al. (2011)
93	*Coccinia adoensis* (A. Rich.) Cogn.	Cucurbitaceae	Uganda	Root	Anaplasmosis	Oral	Gradé et al. (2009)
94	*Cocos nucifera* L.	Arecaceae	India; Brazil	Fruit	Gastrointestinal parasites, Anthelmintic	Oral	Kiruba et al. (2006), Pande et al. (2007), Ganesan et al. (2008), Ritter et al. (2012)
95	*Combretum caffrum* (Eckl. & Zeyh.) Kuntze	Combretaceae	South Africa	Drops from squeezed leaves	Conjunctivitis	Topical	Masika et al. (2000)
96	*Commelina benghalensis* L.	Commelinaceae	Sri Lanka	Leaf; stem	Mastitis	Topical	Nair and Punniamurthy (2016)
97	*Commiphora habessinica* (O.Berg) Engl.	Burseraceae	Uganda	Exudate	Mange	Oral	Gradé et al. (2009)

(continued)

Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
98	*Coriandrum sativum* L.	Apiaceae	India (Uttarakhand)		Fever	Oral	Pande et al. (2007)
99	*Crateva magna* (Lour) DC	Capparaceae	India	Bark	Anthrax	Oral	Upadhyay et al. (2011)
100	*Crocosmia paniculata* (Klatt) Goldbl.	Iridaceae	South Africa	Unspecified	Used for bovine diarrhoea by the Sotho	Oral	Watt and Breyer-Brandwijk (1962)
101	*Croton gratissimus* Burch. var. gratissimus	Euphorbiaceae	South Africa	Leaves, roots	Pneumonia, tonic, fertility enhancement	Oral	Van der Merwe et al. (2001)
102	*Cucumis hardwickii* Royale	Cucurbitaceae	India (Uttarakhand)		Anthelmintic	Oral	Pande et al. (2007)
103	*Cucumis* sp.	Cucurbitaceae	Uganda	Fruit	Anaplasmosis	Oral	Gradé et al. (2009)
104	*Cuminum cyminum* Wall.	Apiaceae	Pakistan	Seed	Mastitis	Oral	Dilshad et al. (2010)
105	*Curtisia dentata* (Burm. f.) C.A.Sm.	Cornaceae	South Africa	Bark	Heartwater in cows	Oral	Dold and Cocks (2001)
106	*Cuscuta reflexa* Decne.	Convolvulaceae	Bhutan; Nepal	Leaf; fruit	Gastric parasites	Oral	Chetri (2013), Malla and Chhetri (2012)
107	*Cymbopogon citratus* (DC.) Stapf.	Poaceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
108	*Cynoglossum zeylanicum* Wight ex Wall.	Boraginaceae	Nepal	Whole plant	Conjunctivitis	Topical	Malla and Chhetri (2012)
109	*Datura metel* L.	Solanaceae	India	Fruit; leaf; root	Dysentery, lack of appetite, cold, bleeding wounds, skin diseases	Oral, topical	Parthiban et al. (2016)
110	*Derris spruceana* (Benth.) Ducke.	Leguminosae	Brazil	Root	Mange	Oral	Ritter et al. (2012)
111	*Dioscorea deltoidea* Wall.	Dioscoreaceae	Nepal	Tuber	Constipation; endoparasites	Oral	Malla and Chhetri (2012)

112	*Diospyros buxifolia* (Blume)	Ebenaceae	India	Fruit	Foot and mouth disease	Oral	Upadhyay et al. (2011)
113	*Dombeya rotundifolia* (Hochst.) Planch.	Sterculiaceae	South Africa	Leaves and flowers	Newcastle disease in chickens, infectious diseases in cattle, personal communication	Oral	Luseba and Van der Merwe (2006)
114	*Dregea volubilis Benth.* ex Hook.f.	Asclepiadaceae	Sri Lanka	Leaf; stem	Skin infection	Topical	Nair and Punniamurthy (2016)
115	*Diospyros montana* Roxb.	Ebenaceae	India	Bark	Dysentery	Oral	Upadhyay et al. (2011)
116	*Elephantorrhiza elephantina* (Burch.) Skeels	Fabaceae	South Africa	Roots, aerial parts and bulb	The Xhosa use roots for diarrhoea and dysentery in cattle, horses and humans, root given to cows for mange; heartwater, blackquarter, appetite stimulant or tonic; diarrhoea, heartwater, coughing, pneumonia	Oral	Watt and Breyer-Brandwijk (1962), Dold and Cocks (2001), Luseba and Van der Merwe (2006), Van der Merwe et al. (2001)
117	*Eleutherine bulbosa* (Mill.) Urb.	Iridaceae	Brazil	Root	Mange	Oral	Ritter et al. (2012)
118	*Emblica officinalis* Gaertn	Euphorbiaceae	India	Fruit	Cough and cold	Oral	Sehgal and Sood (2013)
119	*Enicostemma hyssopifolium* Blume.	Gentianaceae	India	Whole plant	Intestinal worms	Oral	Upadhyay et al. (2011)
120	*Eruca sativa* Mill.	Brassicaceae	India	Seeds oil	Mange and small pox	Topical	Sharma et al. (2012)
121	*Eucalyptus camaldulensis* Dehnh.	Myrtaceae	Pakistan	Flower; leaf	Cold and fever	Topical	Abbasi et al. (2013)
122	*Eucalyptus umbellata* Domin	Myrtaceae	India	Leaf	Cold and fever	Oral	Sehgal and Sood (2013)
123	*Euphorbia bongensis* Kotschy & Peyr.	Euphorbiaceae	Uganda	Whole plant	Anaplasmosis, East Coast fever, pleuropneumonia, heartwater, ticks	Oral	Gradé et al. (2009)
124	*Euphorbia candelabrum* Kotschy	Euphorbiaceae	Uganda	Stem	Anaplasmosis	Oral	Gradé et al. (2009)

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Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
125	*Euphorbia cooperi* N.E.Br. ex A. Berger	Euphorbiaceae	South Africa	Aerial parts	Blackquarter	Oral	Luseba and Van der Merwe (2006)
126	*Euphorbia hirta* L.	Euphorbiaceae	India	Latex	Wound	Topical	Parthiban et al. (2016)
127	*Euphurbia graminifolius*	Compositae	Iran	Soden	Anthelmintic	Oral	Pirbalouti et al. (2009)
128	*Fagopyrum acutatum* (Lehm.) Mansf. ex K. Hammer	Polygonaceae	Pakistan	Aerial	Antimicrobial, diuretic and bactericidal	Oral	Ahmed and Murtaza (2015)
129	*Fagopyrum esculentum* Moench	Polygonaceae	Pakistan	Aerial	Antimicrobial, diuretic and bactericidal	Oral	Ahmed and Murtaza (2015)
130	*Ficus benghalensis* L.	Moraceae	India	Latex, root	Maggot wound, stomach ache	Topical, oral	Parthiban et al. (2016)
131	*Ficus palmata* Forssk.	Moraceae	Pakistan	Leaf	Anthelmintic	Oral	Ahmed and Murtaza (2015)
132	*Ficus racemosa* L.	Moraceae	India	Fruit	Diarrhoea	Oral	Upadhyay et al. (2011)
133	*Fumaria indica* (Hausskn.) Pugsley	Papaveraceae	Pakistan	Whole plant	Diarrhoea	Oral	Abbasi et al. (2013)
134	*Fumaria officinalis* Hohen.	Papaveraceae	India; Pakistan	Leaf; seed	Diarrhoea; fever	Oral	Abbasi et al. (2013), Sehgal and Sood (2013), Pande et al. (2007)
135	*Galium aparine* L.	Rubiaceae	Pakistan	Leaf; seed	Mastitis	Oral	Dilshad et al. (2010)
136	*Geranium pratense* L	Geraniaceae	India (Uttarakhand)		Fever	Oral	Pande et al. (2007)
137	*Gnidia capitata* L. f.	Thymelaeaceae	South Africa	Root decoction	Heartwater in cows, anthrax	Oral	Dold and Cocks (2001)

138	*Gloriosa superba* L.	Liliaceae	India	Leaf	Exposure to disease, mastitis	Oral	Upadhyay et al. (2011), Gerstner (1939), Roberts (1990)
			South Africa	Corms	Used to kill lice, for skin eruptions, tick infections and screw-worm on cattle		
139	*Gossypium barbadense* L.	Malvaceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
140	*Grewia optiva* J. R. Drumm. ex Burret	Tiliaceae	India	Leaf	Remove parasites	Oral	Sharma et al. (2012)
141	*Gymnema sylvestre* (L.) R.Br.	Asclepiadaceae	India	Leaf	Fever	Oral	Parthiban et al. (2016)
142	*Harrisonia abyssinica* Oliv.	Simaroubaceae	Pakistan	Fruit	Endoparasites	Oral	Ul Haq et al. (2011)
143	*Hibiscus malacospermus* E.Mey. ex Harv. & Sond.	Malvaceae	South Africa	Root decoction	Retained placenta, intestinal worms	Oral	Masika et al. (2000)
144	*Hypoxis hemerocallidea* Fisch. & C.A. Mey. [and *Hypoxis rigidula* Baker]	Hypoxidaceae	South Africa	Corms	Fertility enhancement, general ailments, heartwater, abortion	Oral	Van der Merwe et al. (2001)
145	*Hippobromus pauciflorus* (L.f.) Radlk.	Sapindaceae	South Africa	Bark	Bark used for heartwater and diarrhoea in cattle	Oral	Dold and Cocks (2001)
146	*Indigofera frutescens* L.f.	Fabaceae	South Africa	Root bark decoctions	Anthelmintics in animals and humans, especially roundworm	Oral	Watt and Breyer-Brandwijk (1962)
147	*Indigofera sessilifolia* DC.	Fabaceae	South Africa	Roots	Diarrhoea in calves	Oral	Dold and Cocks (2001)

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Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
148	*Isodon rugosus* (Wall. ex Benth.) Codd	Lamiaceae	Pakistan	Aerial	Against flea	Topical	Ahmed and Murtaza (2015)
149	*Jasminum humile* B.Heyne ex Wall.	Oleaceae	India; Pakistan	Root; flower	Fever; pain	Oral	Pande et al. (2007), Sehgal and Sood (2013)
150	*Jasminum multiflorum* Roth	Oleaceae	India	Root; flower	Fever; pain	Oral	Sehgal and Sood (2013), Pande et al. (2007)
151	*Jatropha curcas* L.	Euphorbiaceae	India; Brazil	Root; leaf	Mastitis; anthelmintic	Oral	Ganesan et al. (2008), Ritter et al. (2012)
152	*Kalanchoe pinnata* (Lam.) Pers.	Crassulaceae	Brazil	Leaf	Mange	Oral	Ritter et al. (2012)
153	*Lactuca brunoniana* (DC.) Wall. ex C. B. Clarke	Asteraceae	Pakistan	Whole plant	Pinworms	Oral	Ahmed and Murtaza (2015)
154	*Lannea coromandelica* (Houtt.) Merr	Anacardiaceae	India	Bark	Fever	Oral	Parthiban et al. (2016)
155	*Lantana camara* L.	Verbenaceae	India	Leaf	Measles	Oral	Pande et al. (2007)
156	*Lantana rugosa* Thunb.	Verbenaceae	South Africa	Leaf	Pastes or infusions used for animal and human eye complaints	Topical	Watt and Breyer-Brandwijk (1962)
157	*Launaea procumbens* (Roxb.) Ramayya and Raja Gopal	Asteraceae	India	Root	Diarrhoea	Oral	Upadhyay et al. (2011)
158	*Lavandula lanata* Boiss.	Lamiaceae	Spain	Flowering stems	Cold	Oral	Benítez et al. (2012)
159	*Lavandula latifolia* Medik.	Lamiaceae	Spain	Flowering stems	Cold	Oral	Benítez et al. (2012)

160	*Lawsonia inermis* L.	Lythraceae	Afghanistan; India	Leaf	Cough; urinary infection	Oral	Davis et al. (1995), Pande et al. (2007)
161	*Lecythis pisonis* Cambess.	Lecythidaceae	Brazil	Leaf	Mange	Oral	Ritter et al. (2012)
162	*Leptopus cordifolius* Decne.	Phyllanthaceae	Pakistan	Roots, leaf	Anthelmintic	Oral	Ahmed and Murtaza (2015)
163	*Lippia alba* (Mill.) N.E.Br.	Verbenaceae	Brazil	Root	Anthelmintic	Oral	Ritter et al. (2012)
164	*Madhuca indica* J. F. Gmel	Sapotaceae	India	Flower	Fever	Oral	Parthiban et al. (2016)
165	*Maesa chisia* D. Don	Myrsinaceae	Nepal	Bark	Ringworm	Topical	Malla and Chhetri (2012)
166	*Marrubium supinum* L.	Lamiaceae	Spain	Flowering stems	Cold	Oral	Benítez et al. (2012)
167	*Marrubium vulgare* L.	Lamiaceae	Spain	Flowering stems	Cold	Oral	Benítez et al. (2012)
168	*Mallotus philippensis* (Lam.) Mull. Arg.	Euphorbiaceae	Afghanistan	Seed	Gastrointestinal worms	Oral	Davis et al. (1995)
169	*Mangifera indica* Thwaites	Anacardiaceae	Bangladesh	Leaf	Gastrointestinal parasites	Oral	Sujon et al. (2008)
170	*Melia azedarach* L.	Meliaceae	Pakistan	Seeds	Anthelmintic	Oral	Ahmed and Murtaza (2015)
171	*Momordica charantia* L.	Cucurbitaceae	Bangladesh	Leaf	Gastrointestinal parasites	Oral	Sujon et al. (2008)
172	*Moringa oleifera* Lam.	Moringaceae	Bhutan	Bark; leaf	Skin infection	Topical	Chetri (2013)
173	*Musa paradisiaca* L.	Musaceae	India	Fruit	Measles	Topical	Phondani et al. (2010), Pande et al. (2007), Ganesan et al. (2008)

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Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
174	*Myrsine semiserrata* Wall.		India (Uttarakhand)	Unspecified	Diarrhoea	Oral	Pande et al. (2007)
175	*Myrtus communis* Blanco	Myrtaceae	Pakistan	Leaf	Diarrhoea	Oral	Ul Hassan et al. (2014)
176	*Mystroxylon aethiopicum* (Thunb.) Loes.	Celastraceae	South Africa	Bark	Heartwater in cattle, worms in calves, intestinal parasites	Oral	Dold and Cocks (2001)
177	*Nicotiana rustica* L.	Solanaceae	Pakistan	Leaf	Ectoparasites	Topical	Ul Hassan et al. (2014)
178	*Nicotiana tabacum* L.	Solanaceae	India	Leaf	Intestinal worms	Oral	Pande et al. (2007), Van der Merwe et al. (2001)
			South Africa		Eye infections		
179	*Ocimum basilicum* L.	Lamiaceae	India	Leaf and seed	Skin infection	Topical	Pande et al. (2007), Ganesan et al. (2008)
180	*Ocimum canum* Sim	Lamiaceae	India	Seed, leaf	Diarrhoea, insect repellant	Oral, topical	Upadhyay et al. (2011)
181	*Ocimum tenuiflorum* L.	Lamiaceae	India	Leaf and seed	Cough; fever	Oral	Pande et al. (2007), Sehgal and Sood (2013)
182	*Origanum vulgare* L.	Lamiaceae	India (Uttarakhand)		Diarrhoea	Oral	Pande et al. (2007)
183	*Ouratea aquatica* Engl.	Ochnaceae	Brazil	Bark	Mange	Oral	Ritter et al. (2012)
184	*Pelargonium reniforme* Curtis	Geraniaceae	South Africa	Root decoction	Diarrhoea in goats and cows, heartwater in cattle, liver disorders in cattle and sheep	Oral	Dold and Cocks (2001)
185	*Pelargonium sidoides* DC.	Geraniaceae	South Africa	Decoction of unspecified parts	Used as anthelmintics for calves with *Ziziphus zeyheriana* Sond.	Oral	Watt and Breyer-Brandwijk (1962)

186	*Peltophorum africanum* Sond.	Fabaceae	South Africa	Bark, root bark	Tonic, diarrhoea	Oral	Van der Merwe et al. (2001)
187	*Phyllanthus burchellii* Müll. Arg. and *Phyllanthus parvulus* Sond.	Euphorbiaceae	South Africa	Aerial parts	Eye infections	Topical	Van der Merwe et al. (2001)
188	*Pinus wallichiana* A.B. Jacks.	Pinaceae	Afghanistan	Resin	Cough; endoparasites	Oral	Davis et al. (1995)
189	*Pinus roxburghii* Sar.	Pinaceae	Pakistan	Oil	Mange	Topical	Farooq et al. (2008)
190	*Piper betle* L.	Piperaceae	India; Bangladesh	Leaf	Constipation; endoparasites	Oral	Nair and Chanda (2008), Satapathy, (2010), Ganesan et al. (2008), Sujon et al. (2008)
191	*Plantago ovata* Forssk.		India (Uttarakhand)		Chicken pox	Oral	Pande et al. (2007)
192	*Plumbago auriculata* Lam.	Plumbaginaceae	South Africa	Roots	Diarrhoea in cows	Oral	Dold and Cocks (2001)
193	*Plumbago zeylanica* L.	Plumbaginaceae	South Africa	Roots	Pneumonia	Oral	Van der Merwe et al. (2001)
194	*Polygala hottentotta* Presl	Polygalaceae	South Africa	Unspecified parts	Anthrax	Oral	Guillarmod (1971)
195	*Polygala spectabilis* DC.	Polygalaceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
196	*Potentilla eriocarpa* Wall.	Rosaceae	India (Uttarakhand)		Diarrhoea	Oral	Pande et al. (2007)
197	*Premna barbata* Wall. ex Schauer	Lamiaceae	India (Uttarakhand)		Throat infection	Oral	Pande et al. (2007)
198	*Prunus cerasoides* D. Don	Rosaceae	India (Uttarakhand)		Fever	Oral	Pande et al. (2007)

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Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
199	*Prunus persica* (L.) Batsch.	Rosaceae	India (Uttarakhand)		External and internal parasites, intestinal worms in hen	Oral	Pande et al. (2007)
200	*Punica granatum*	Lythraceae	India (Uttarakhand)		Fever, intestinal parasites	Oral	Pande et al. (2007)
201	*Pyrus pashia* Buch.-Ham. ex D. Don	Plumbaginaceae	India	Root, leaf	Mange, appetite stimulant	Topical, oral	Sharma et al. (2012)
202	*Primula denticulata* Sm.	Primulaceae	Pakistan	Whole plant decoction	Hepatic fever, dysuria and hemoglobinuria	Oral	Ahmed and Murtaza (2015)
203	*Protasparagus virgatus* (Bak.) Oberm.	Asparagaceae	South Africa		Root infusions or decoctions Anthelmintics for animals and humans	Oral	Watt and Breyer-Brandwijk (1962)
204	*Protea caffra* Meisn.	Proteaceae	South Africa	Root bark decoctions	Enemas given to calves with bloody diarrhoea	Oral	Hutchings et al. (1996)
205	*Protea welwitschii* Engl.	Proteaceae	South Africa	Decorticated root infusions	Dysentery and diarrhoea in calves and humans	Oral	Watt and Breyer-Brandwijk (1962)
206	*Prunus persica* (L.) Batsch.	Rosaceae	South Africa	Leaf decoctions, root	Leaf decoction for diarrhoea in lambs and kid goats, roots for broken bones	Oral	Dold and Cocks (2001)
207	*Psidium guajava* L.	Myrtaceae	Bhutan; India; Pakistan	Leaf	Dysentery; diarrhoea	Oral	Sehgal and Sood (2013), Chetri (2013), Farooq et al. (2008)
208	*Ptaeroxylon obliquum* (Thunb.) Radlk.	Ptaeroxylaceae	South Africa	Wood	Anthrax remedy, for ticks in cattle	Oral	Hutchings et al. (1996)
209	*Punica granatum* L.	Lythraceae	India; Bhutan	Leaf; fruit	Fever; skin infection	Oral; Topical	Pande et al. (2007), Chetri (2013), Dilshad et al. (2010)
210	*Pyrus pashia* Buch.-Ham. ex D.Don	Rosaceae	India	Fruit	Eye infection	Topical	Sharma et al. (2012)

211	*Quassia amara* L.	Simaroubaceae	Brazil	Leaf	Anthelmintic	Oral	Ritter et al. (2012)
212	*Quercus baloot* Griff.	Fagaceae	Pakistan	Leaf	Urinary infections	Oral	Ul Hassan et al. (2014)
213	*Quercus brantii* Lindl.	Rhamnaceae	Ilam (Iran)	Fruit	Anti-candida	Topical	Pirbalouti et al. (2009)
214	*Rapanea melanophloeos* (L.) Mez	Myrsinaceae	South Africa	Bark	Heartwater in cows	Oral	Dold and Cocks (2001)
215	*Rhoicissus tomentosa* (Lam.) Wild & Drum.	Vitaceae	South Africa	Root	Anthelmintics for calves	Oral	Watt and Breyer-Brandwijk (1962)
216	*Rhoicissus tridentata* (L.f.) Wild & Drum.	Vitaceae	South Africa	Tubers	Cattle diseases; diarrhoea in goats and sheep; heartwater, redwater, internal parasites, general ailments, abortion	Oral	Pujol, (1990), Dold and Cocks (2001), Van der Merwe et al. (2001)
217	*Rhus chinensis* Mill.	Anacardiaceae	Nepal	Leaf	Foot and mouth disease	Oral	Malla and Chhetri (2012)
218	*Rumex nepalensis* Spreng.	Polygonaceae	Pakistan	Whole plant	Hepatitis, malarial fever, dysuria and red urination	Oral	Ahmed and Murtaza (2015)
219	*Sapindus mukorossi* Gaertn.	Sapindaceae	India	Fruit	Removes leeches	Topical	Sharma et al. (2012)
220	*Salsola baryosma* (Roem. Et. Scult.) Dany.	Chenopodiaceae	Pakistan	Aerial	Helminthiasis	Oral	Farooq et al. (2008)
221	*Salsola rigida*	Solanaceae	Iran	Aerial parts	Anthelmintic	Oral	Pirbalouti et al. (2009)
222	*Sansevieria hyacinthoides* (L.) Druce	Dracaenaceae	South Africa	Leaf sap	Fresh leaf sap applied to eyes of sheepand goats for conjunctivitis	Topical	Dold and Cocks (2001)
223	*Sansevieria roxburghiana* Schult.f.	Dracaenaceae	India; Bangladesh	Leaf	Fever	Oral	Pragada and Rao (2012), Reddy et al. (2006)

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Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
224	*Satureja bachtiarica* Bunge.	Lamiaceae	Chaharmahal va Bakhtiari (Iran)	Aerial parts	Anti-candida	Topical	Pirbalouti et al. (2009)
225	*Schkuhria pinnata* (Lam.) Thell.	Asteraceae	South Africa	Aerial parts	Eye infections, pneumonia, diarrhoea, heartwater	Oral	Van der Merwe et al. (2001)
226	*Schotia brachypetala* Sond.	Fabaceae	South Africa		Infectious diseases in cattle	Oral	Van der Merwe et al. (2001)
227	*Schotia latifolia* Jacq.	Fabaceae	South Africa	Bark decoction	Redwater in cattle	Oral	Dold and Cocks (2001)
228	*Scirpoides holoschoenus* (L.) Sojak	Scirpaceae	Spain	Leaf	Cold	Oral	Benítez et al. (2012)
229	*Scrophularia deserti*	Scrophulariaceae	Iran	Aerial parts	Disinfection of wounds	Topical	Pirbalouti et al. (2009)
230	*Scrophularia striata* Boiss.	Scrophulariaceae	Ilam (Iran)	Aerial parts	Anti-candida	Topical	Pirbalouti et al. (2009)
231	*Senecio chrysanthemoides* DC.	Asteraceae	Pakistan	Aerial parts	Anthelmintic, antiscorbutic and diaphoretic	Oral	Ahmed and Murtaza (2015)
232	*Senecio tamoides* DC.	Asteraceae	South Africa	Unspecified	Anthrax and 'quarter evil' in cattle	Oral	Gerstner (1939)
233	*Senna italica* Mill.	Fabaceae	South Africa	Bark, roots	Diarrhoea and gallsickness, intestinal diseases, heartwater, anthrax, pneumonia	Oral	Luseba and Van der Merwe (2006), Van der Merwe et al. (2001)
234	*Senna occidentalis* (L.) Link	Caesalpiniaceae	India	Leaf	Diarrhoea	Oral	Sehgal and Sood (2013)
235	*Sesbania sesban* L.	Fabaceae	India	Seed	Diarrhoea, exposure to disease	Oral	Upadhyay et al. (2011)

236	*Stephania glabra* (Roxb.) Miers.	Menispermaceae	India (Uttarakhand)		Vermifuge	Oral	Pande et al. (2007)
237	*Sida acuta* Burm. f.	Malvaceae	India	Leaf	Diarrhoea	Oral	Pragada and Rao (2012)
238	*Skimmia laureola* Franch	Rutaceae	Pakistan	Leaf	Cold, shivering (ague) diarrhoea, dysentery, and anti-worms	Oral	Ahmed and Murtaza (2015)
239	*Solanum aculeastrum* Dun.	Solanaceae	South Africa	Fruit	Ringworm in cattle and horses and also for anthrax	Topical	Hutchings et al. (1996)
240	*Solanum capense* L.	Solanaceae	South Africa	Fruit	Fruit pulp used by Xhosa for warts and ringworm in animals and humans, fruit sap for sores, distemper and sore eyes in dogs	Topical	Watt and Breyer-Brandwijk (1962)
241	*Solanum indicum* L.	Solanaceae	Nepal	Leaf	Ringworm	Topical	Malla and Chhetri (2012)
242	*Solanum panduriforme* E. Mey.	Solanaceae	South Africa	Fruit sap	Diarrhoea	Oral	Van der Merwe et al. (2001)
243	*Sophora mollis* Graham	Leguminosae	Afghanistan	Leaf; flower	Liver flukes	Oral	Davis et al. (1995)
244	*Stangeria eriopus* (Kunze) Baill.	Zamiaceae	South Africa	Rootstock	Internal parasites in livestock	Oral	Dold and Cocks (2001)
245	*Stipa tenacissima* L.	Poaceae	Spain	Leaf	Cold	Oral	Benítez et al. (2012)
246	*Strychnos decussata* (Pappe)	Loganiaceae	South Africa	Bark infusion	Roundworm in cows	Oral	Dold and Cocks (2001)
247	*Strychnos henningsii* Gilg.	Loganiaceae	South Africa	Bark infusion	Heartwater and diarrhoea in cattle	Oral	Dold and Cocks (2001)
248	*Synadenium cupulare* (Boiss.) L.C. Wheeler	Euphorbiaceae	South Africa	Milky latex	Eye infection, blackquarter	Topical	Luseba and Van der Merwe (2006)
249	*Tanacetum polycephalum* Schultz.	Asteraceae	Tansy (Iran)	Flower	Anti-candida	Topical	Pirbalouti et al. (2009)

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Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
250	*Tephrosia macropoda* (E. Mey.) Harv.	Fabaceae	South Africa	Roots, seeds, leaves	Roots and seeds used for killing vermin on animals and humans; leaf extracts used as anthelmintics forcattle	Oral	McGaw and Eloff (2008)
251	*Tetradenia riparia*	Lamiaceae	South Africa	Leaves	Used for gallsickness and fevers in cattle	Oral	Hutchings et al. (1996)
252	*Thymus daenensis* Celak.	Lamiaceae	Chaharmahal va Bakhtiari (Iran)	Aerial parts	Anti-candida	Topical	Pirbalouti et al. (2009)
253	*Thymbra spicata* L.	Lamiaceae	Ilam (Iran)	Aerial parts	Anti-candida	Topical	Pirbalouti et al. (2009)
254	*Tithonia diversifolia* (Hemsl.) A. Gray.	Asteraceae	Brazil	Leaf	Mange	Oral	Ritter et al. (2012)
255	*Trachyspermum ammi* Sprague	Apiaceae	India	Seed	Diarrhoea, indigestion, fever	Oral	Sharma et al. (2012)
256	*Trachyspermum ammi* (L.) Sprague ex Turrill./ *Carum copticum* L.	Apiaceae	Isfahan (Iran)	Seed/fruits	Anti-candida	Topical	Pirbalouti et al. (2009)
257	*Tribulus terrestris* L.	Zygophyllaceae	India	Leaf	Diarrhoea	Oral	Parthiban et al. (2016)
258	*Trichosanthes bracteata* (Lam.) Voigt.	Cucurbitaceae	India (Uttarakhand)		Fever	Oral	Pande et al. (2007)
259	*Trigonella foenum-graecum* L.	Fabaceae	India (Uttarakhand)		Pneumonia	Oral	Pande et al. (2007)
260	*Tylophora hirsuta* Wight	Asclepiadaceae	India	Latex	Eye infection	Topical	Sharma et al. (2012)

261	*Urginea sanguinea* Schinz	Hyacinthaceae	South Africa	Bulbs	General ailments, intestinal diseases, internal parasites, gallsickness, heartwater, redwater, sores, retained placenta	Oral	Van der Merwe et al. (2001)
262	*Vernonia mespilifolia* Less.	Asteraceae	South Africa	Stems	Heartwater in goats	Oral	Dold and Cocks (2001)
263	*Vernonia neocorymbosa* Hilliard	Asteraceae	South Africa	Roots, leaves	Used by Zulus to treat calves; root decoctions administered by Lobedu as anthelmintics to donkey; pounded leaf and root infusions administered by Vhavenda as anthelmintics to domestic animals	Oral	Gerstner, (1939), Hutchings et al. (1996)
264	*Vicatia stewartii* C. B. Clarke		India (Uttarakhand)		Fever	Oral	Pande et al. (2007)
265	*Vitex negundo* L.	Verbenaceae	India	Leaf; root	Infectious diseases, diarrhoea, dysentery	Oral	Parthiban et al. (2016)
266	*Vitex zeyheri* Sond. ex Schauer	Verbenaceae	South Africa	Leaf	Eye infections	Topical	Van der Merwe et al. (2001)
267	*Watsonia densiflora* Bak.	Iridaceae	South Africa		Diarrhoea in calves by the Sotho	Oral	Watt and Breyer-Brandwijk (1962)
268	*Woodfordia floribunda* Salisb.	Lythraceae	India (Uttarakhand)		Fever	Oral	Pande et al. (2007)
269	*Wrightia arborea* (Dennst.) Mabb.	Apocynaceae	India	Leaf	Parasitic infestation	Topical	Upadhyay et al. (2011)
270	*Ximenia americana* L. var. microphylla	Olacaceae	South Africa	Roots	Internal parasites	Oral	Van der Merwe et al. (2001)
271	*Zanthoxylum acanthopodium* DC.	Rutaceae	India (Uttarakhand)		Anthelmintic	Oral	Pande et al. (2007)

(continued)

Table 3.1. (continued)

PN	Plant name	Family	Region(s)	Part(s) used	Disease(s) treated	Application	Citations
272	*Zingiber officinale* Roscoe.	Zingiberaceae	Pakistan	Rhizome	Helminthiasis	Oral	Farooq et al. (2008)
273	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	Rhamnaceae	India	Leaf, root	Conjunctivitis, exposure to disease, fever, placenta retention, Tumpley	Oral	Upadhyay et al. (2011)
274	*Ziziphus spina-christi* (L.) Willd.	Fagaceae	Ilam (Iran)	Fruit	Anti-candida	Topical	Pirbalouti et al. (2009)
275	*Ziziphus zeyheriana* Sond.	Rhamnaceae	South Africa	Root-stock	Diarrhoea, internal parasites, general ailments	Oral	Pande et al. (2007), Van der Merwe et al. (2001)

Since the 1940s, antibiotics were fed to livestock animals to boost their productivity by growing them bigger faster and at a cheaper price (Coates et al. 1951; Elliott 2015; Moore et al. 1946; Sneeringer et al. 2015; Stokstad and Jukes 1950). Nonetheless, over the years many antibiotics which were once used successfully to attenuate or kill disease-causing microorganisms have now become inefficacious. In addition, substantial evidence exists surrounding the development of resistant bacterial strains and their subsequent spread to humans and the food chain. In certain countries such as in the United States, colossal amounts of antibiotics are injected into livestock such that in 2015, 17 000 tons of antibiotics were reported to be used and represented four times the amount of antibiotics sold for human use in that particular year (FDA 2015).

The development of resistant bacterial strains in animals and their transmission to humans is inevitable. Given these pressing concerns, various healthcare organizations, chiefly the World Health Organization, US Centers for Disease Control and Prevention, European Medicines Agency and Institute of Medicine among others, have laid particular emphasis on this issue. Ever since the creation of the first antibiotic, signs of resistance became evident. One of the most prominent reasons for the antibiotic resistance phenomenon remains the fact that these drugs are either misused or overused. Interestingly, studies have demonstrated that farm animals treated with tetracyclines can become resistant to the drug within 2 weeks and this resistance can spread among the skilled labourers as demonstrated by the presence of tetracycline-resistant bacteria in their stools (Spellberg et al. 2016).

Over the years, the number of antibiotic leads and novel antibiotics proposed by pharmaceutical companies has stalled considerably. Hence, there is an urgent need to provide newer classes of antibiotics or to derive modern strategies to combat disease-causing microorganisms. In this scenario, nature provides an armamentarium of resources that can be explored as new sources of antibiotics. The use of plant species for managing health problems among animals is an ancient and fruitful approach. The development of plant extracts of single or combined plants as well as the combination of antimicrobial plant extracts with conventional drugs can unlock noticeable strategies in the fight against disease-causing microorganisms. Nonetheless, to reach there, knowledge regarding plant species with striking antimicrobial activity needs to be disseminated properly.

Consequently, this chapter aims to highlight plant species with plausible antimicrobial activity based on successful previous and current use to prevent and treat animal infectious ailments. In furtherance, in vitro studies conducted on plant species with noticeable activity on disease-causing microorganisms are also discussed. Considering plant species mentioned in this chapter for further pharmacological screening can undeniably promote the diversification of available plant resources in the hunt for novel antimicrobials.

3.2 Novel Antimicrobials and the Need for Ethnoveterinary Studies

One of the prime purposes of conducting ethnoveterinary studies is to firstly document the available time-tested traditional remedies that have been employed safely through time in different regions of the world and to consequently disseminate available information for consolidation of those existing practices. Secondly, the scientific aim of directing such research is focused mainly on the validation of the claimed properties of the remedies.

Remarkably, in various developing and underdeveloped nations of the world, livestock rearing is a major source of food and income to the local inhabitants. Naturally, caring for the health and well-being of the animals is a prime preoccupation of those inhabitants. As a matter of fact, allopathic medicines are rarely affordable and accessible in those areas, and people tend to rely on nature to alleviate the suffering of animals under their care. Undeniably, this knowledge has been passed on from generation to generation and has been successful to a great extent given that such practices are still used to a great extent as previously demonstrated (Lans 2011).

Furthermore, zoopharmacognosy, described as the practice through which animals self-medicate with plants, remains an unexplored area which deserves particular attention as it may help unveil novel antimicrobials. Since various antimicrobials are becoming inefficacious due to the antimicrobial resistance phenomena, plants provide a vast avenue that can be explored as potential antimicrobials. Plants consist of secondary metabolites which act on diverse pharmacological targets and might be used to address more than one animal ailment. In addition, since many disease-causing microbes in animals also cause infections in human beings, deciphering novel antimicrobials from ethnoveterinary studies will undeniably contribute to the discovery of useful phytoconstituents which can be used for human infections as well.

3.3 In Vitro Studies

An in vitro assay constituting 17 plant species was conducted against common disease-causing microbial agents in South Africa. Three different solvents were used to prepare the extracts, and their antibacterial activity was assayed against two Gram-positive *Enterococcus faecalis* (ATCC 29212) and *Staphylococcus aureus* (ATCC 29213) and Gram-negative bacteria *Pseudomonas aeruginosa* (ATCC 27853) and *Escherichia coli* (ATCC 25219), respectively. Anthelmintic activity was determined by assaying the plant extracts against the free living nematode *Caenorhabditis elegans*, while the toxicity was investigated via the brine shrimp (*Artemia salina*) larval mortality test (McGaw et al. 2007).

The most noteworthy results of the study demonstrated that three extracts displayed anthelmintic activity and brine shrimp lethality alongside antibacterial activity. Indeed, these were the hexane extract of *Berchemia zeyheri* and the methanol extract of *Pterocarpus angolensis* DC. bark alongside the stem/leaf extract of *Ricinus communis* L. Interestingly, antibacterial activity was noted from most plant extracts with the best minimum inhibitory concentration (MIC) recorded being 0.1 mg/ml. Overall, more than 30% of the extracts had anthelmintic properties, while 30% of extracts showed toxic effects against the brine shrimp larvae with the lowest lethal concentration (LC_{50}) recorded being 0.6 mg/ml (McGaw et al. 2007).

Hexane, dichloromethane, acetone and methanol extracts of six plant species, namely, *Acokanthera schimperi* (A.DC.) Benth. var. *rotundata* Codd., *Carissa edulis* (Forssk.) Vahl., *Ekebergia capensis* Sparrm, *Podocarpus henkelii* Stapf ex Dallim. & Jacks., *Plumbago zeylanica* L. and *Schrebera alata* (Hochst.) Welw. were assayed in vitro for their antiviral activities against the following viruses: canine distemper virus (CDV), canine parainfluenza virus-2 (CPIV-2), feline herpesvirus-1 (FHV-1) and lumpy skin disease virus (LSDV). Cytotoxic evaluation of all extracts was also performed employing the colorimetric tetrazolium-based (MTT) assay. The antiviral activities were investigated using the virucidal and attachment assays. In the virucidal assay, the extracts were incubated with the virus prior to infection. The most striking results were recorded with the acetone and methanol extracts of *P. henkelii* against CDV and LSDV with an inhibition of replication at a proportion of more than 75% at a concentration of 3 μg/ml. Noticeable results were also registered from the hexane extracts of *C. edulis* and *P. zeylanica* against CDV while reducing viral-induced cytopathic effect by 75% and 50%, respectively. On the other hand, the hexane extract of *C. edulis* displayed mild activity against FHV-1 with half maximal effective concentration (EC_{50}) of less than 70 μg/ml. Among all the extracts, only the acetone extract of *P. henkelii* inhibited the replication of the LSD virus in the replication assay (Bagla et al. 2012).

Another study investigated the antifungal activities of 13 plant species used in South Africa to treat gastrointestinal helminth infections in livestock and man. These plants included *Brachylaena discolor*, *Zanthoxylum capense*, *Clerodendrum glabrum*, *Heteromorpha trifoliata*, *Apodytes dimidiata*, *Strychnos mitis*, *Maesa lanceolata*, *Indigofera frutescens*, *Leucosidea sericea*, *Melia azedarach*, *Clausena anisata*, *Cyathea dregei* and *Millettia grandis*. One gram of each plant investigated was extracted with 10 ml of acetone. The antifungal abilities of the plant extracts were investigated on three different fungal species, namely, *Candida albicans*, *Cryptococcus neoformans* and *Aspergillus fumigatus* isolated from a Gouldian finch, a cheetah and a chicken, respectively. The results obtained demonstrated that eight of the plant extracts excluding extracts from *H. trifoliata*, *S. mitis*, *M. lanceolata*, *M. azedarach* and *C. dregei* extracts recorded MIC values less than 0.1 mg/mL. This may be correlated to the fact that these plants are traditionally used as anthelmintics. Based on the cytotoxicity results and from the antifungal assays, the promising two plants species were *C. anisata* and *C. glabrum* (Adamu et al. 2012).

Mastitis is mostly of bacterial, fungal or viral origin (Tiwari et al. 2013). Clinical symptoms of mastitis involve the secretion of abnormal milk and an inflammatory condition which results in redness, swelling and hardness of the udder (Chebel 2007; Sharif and Muhammad 2009). The most common microorganisms involved in mastitis pathogenesis involve *Corynebacterium bovis*, *Mycoplasma* species, *Streptococcus agalactiae*, *Staphylococcus aureus*, *Staphylococcus chromogenes* (coagulase-negative staphylococci), *Streptococcus dysgalactiae* and *Streptococcus uberis* (Ahmad 2001; Erskine 2001; Khan 2002).

A study undertook an in vitro investigation of the aqueous and methanolic extracts of three plant species *Asteracantha longifolia*, *Dactyloctenium indicum* and *Trichodesma indicum* against microbial bovine mastitis. Extracts of the plant *A. longifolia* demonstrated noticeable activity against the tested bacterial candidates which were *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus agalactiae* and *Klebsiella pneumoniae*, respectively. The methanolic extract resulted in an inhibition zone of 25 mm against *S. aureus* at a concentration of 200 mg/ml, while an inhibition zone of 16 mm against *E. coli* resulted at the same concentration (Mubarack et al. 2011).

A study performed by Sserunkuma et al. (2017) involved the preparation of water and acetone extracts from *Acacia nilotica*, *Aloe arborescens*, *Crassula multicava* and *Tetradenia riparia*. The methodology involved in determining the antimicrobial activity was the serial microdilution method, while cytotoxicity was assayed employing a mammalian kidney cell line including a tetrazolium-based colorimetric assay. The most marked resulted against Gram-positive and Gram-negative bacteria (*Enterobacter* aerogenes, *Proteus vulgaris*) were recorded for acetone extracts of *A. nilotica* bark and *T. riparia* plants with MIC values for Gram-negative bacteria as low as 0.0195 mg/ml. The most prominent selectivity index value was retrieved for *T. riparia* flower acetone extract against the field strain *Streptococcus uberis* (Table 3.2).

Table 3.2 South African plants screened for antimicrobial properties

Plant species	Assay	Reference
Rhus lancea L.f.	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Sclerocarya birrea (A. Rich.) Hochst.	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Secamone filiformis (L.f.) J.H.Ross	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Cussonia spicata Thunb.	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Sarcostemma viminale (L.) R. Br.	Antibacterial, anti-inflammatory, mutagenic	Luseba et al. (2007)
Aloe marlothii Berger	Antibacterial, anti-inflammatory, mutagenic anti-rickettsial; anti-babesial	Luseba et al. (2007), Naidoo et al. (2005)
Schkuhria pinnata (Lam.) Thell.	Antibacterial, anthelmintic, brine shrimp toxicity, antibacterial, anti-inflammatory, mutagenic	McGaw et al. (2007), Luseba et al. (2007)

(continued)

Table 3.2 (continued)

Plant species	Assay	Reference
Combretum caffrum (Eckl. & Zeyh.) Kuntze	Antibacterial, antifungal	Masika and Afolayan (2003)
Jatropha zeyheri Sond.	Antibacterial, anti-inflammatory, mutagenic	Luseba et al. (2007)
Ricinus communis L.	Antibacterial, anthelmintic, brine shrimp toxicity; antibacterial, anti-inflammatory, mutagenic	McGaw et al. (2007), Luseba et al. (2007)
Synadenium cupulare (Boiss.) L.C. Wheeler	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Peltophorum africanum Sond.	Antibacterial, antioxidant, anthelmintic	Bizimenyera et al. (2005, 2006a, b)
Pterocarpus angolensis DC.	Antibacterial, anthelmintic, brine shrimp toxicity; antibacterial, anti-inflammatory, mutagenic	McGaw et al. (2007), Luseba et al. (2007)
Schotia brachypetala Sond.	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Schotia latifolia Jacq.	Antibacterial, antifungal	Masika and Afolayan (2003)
Dicerocaryum eriocarpum (Dcne.) J.Abels and *Dicerocaryum senecioides* (Kltzsch.) J.Abels	Antibacterial, anthelmintic, brine shrimp toxicity; antibacterial, anti-inflammatory, mutagenic	McGaw et al. (2007), Luseba et al. (2007)
Berchemia zeyheri (Sond.) Grubov	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Ziziphus mucronata Willd.	Antibacterial, anthelmintic, brine shrimp toxicity antibacterial, anti-inflammatory, mutagenic	McGaw et al. (2007), Luseba et al. (2007)
Salix L. spp.	Antibacterial, antifungal	Masika and Afolayan (2003)
Hippobromus pauciflorus (L.f.) Radlk	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Dombeya rotundifolia (Hochst.) Planch	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Gnidia capitata L.f.	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Pouzolzia mixta Solms	Antibacterial, anthelmintic, brine shrimp toxicity	McGaw et al. (2007)
Cissus quadrangularis L.	Antibacterial, anthelmintic, brine shrimp toxicity antibacterial, anti-inflammatory, mutagenic	McGaw et al. (2007), Luseba et al. (2007)

The laboratory investigation from Luseba et al. (2007) revealed that *Cissus quadrangularis* stem and *Jatropha zeyheri* bear the potential of selectively inhibiting the cyclooxygenase-2 enzymes. The antibacterial assay performed by Bizimenyera et al. (2005) included a serial microplate dilution technique. The tested microorganisms were the Gram-positive bacteria *Staphylococcus aureus* and the Gram-negative microbe *Pseudomonas aeruginosa* (Gram-negative) in organic solvent extracts of

Peltophorum africanum (Fabaceae). The plant extracts demonstrated noticeable antimicrobial activity. In another investigation (Masika and Afolayan 2002) the plant extracts *Combretum caffrum*, *Salix capensis* and *Schotia latifolia* were tested for their antimicrobial and antifungal effects. Good minimum inhibitory concentration values as low as 0.1 mg/ml were obtained against Gram-positive bacteria. Interestingly, preliminary screening has revealed that the plant *Ziziphus mucronata* possesses good antibacterial properties. More extensive investigation on the plant has revealed that its leaves contain the metabolites 2,3-dihydroxyl-up-20-en-28-oic acid and zizyberanalic acid (Moloto 2004) which have excellent activity against *S. aureus*, hence lending support to the validation of the ethnopharmacological claims surrounding the use of the crushed leaves in animal infections.

3.4 Discussion

Since the 1940s antibiotics have been used to boost animal growth and production of food derived from them. Nonetheless, the synthesis and use of antibiotics has, along the way, resulted in the phenomenon of antimicrobial resistance where microorganisms have derived new ways to evade the lethal effects of antimicrobial agents. Interestingly, the use of herbal medicine to treat animal ailments is an ancient practice existing in various parts of the world. Knowledge pertaining to the medicinal properties of plants has been transferred from generation to generation. Strikingly, these remedies have proven to be efficacious in alleviating various animal ailments and have often been proven to be safe. Combined with the fact that novel antibiotics and leads proposed by pharmaceutical companies have dwindled during recent years, herbal medicines can unlock new avenues in unveiling novel antimicrobial compounds.

Ethnoveterinary studies allow for the dissemination of existing medicinal plant information. The documentation of plants with claimed medicinal properties provides a certain opportunity for scientists to validate the effects of those plant species. With particular emphasis on microbial infections, plant-based antimicrobials can provide to be useful in humans as well, owing to the fact that many infectious agents causing diseases in animals are also involved in human infections. The derivation of plant-based extracts with antimicrobial properties is also an interesting avenue to propose natural antibiotics which are much cheaper and more easily available, both to developed and underdeveloped nations.

This chapter mentions 275 plant species used in different countries of the world to treat infectious ailments in animals. Plants listed in this chapter provide an indication of medicinal plants used in parts of Africa including South Africa and Uganda; in parts of Asia such as in India, Nepal, Afghanistan and Pakistan; as well as in other countries such as Brazil and Iran. Undeniably, a plethora of other plant species are also employed in other regions of the world which have not been mentioned in this chapter.

Enthrallingly, the results of in vitro studies provide valuable insights with respect to the antimicrobial properties of plants used in traditional medicine systems over the world. Of particular interest, given their promising antimicrobial properties, are hereby highlighted a plethora of plant species and/or extracts. For example, the hexane extract of *B. zeyheri*, the methanolic extract of *P. angolensis* and the stem/leaf extract of *R. communis* have good in vitro antimicrobial activity. In addition, the acetone and methanol extracts of *P. henkelii* possessed noticeable antiviral activity. Methanolic and aqueous extracts of *A. longifolia* demonstrated good activity against *S. aureus*. Acetone extracts of *A. nilotica* bark and *T. riparia* were highly active against Gram-positive and Gram-negative bacteria (*Enterobacter aerogenes* and *Proteus vulgaris*). *Pseudomonas aeruginosa* (Gram-negative) was susceptible to organic solvent extracts of *P. africanum* (Fabaceae), and *Z. mucronata* extracts were active against *S. aureus*.

3.5 Conclusion

Animals are faced with diverse infections throughout their lives. The antimicrobial resistance phenomenon provides no other option to scientists rather than to explore alternative sources of antimicrobials such as herbal medicines. An innumerable number of herbal remedies have been used by human beings to alleviate the suffering of animals resulting from infections since time immemorial. Indeed, this chapter lists 275 plant species used against animal infections as well as in vitro studies used to validate the claimed properties of the plants. This chapter provides valuable insights on the use of plants in animal infectious diseases. Evaluation of these plant species can identify novel compounds and/or plant-based extracts that can be used as antimicrobial agents in animals to relieve them from suffering.

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Chapter 4
Ethnoremedies Used for Horses in British Columbia and Trinidad and Tobago

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Keywords Ethnoremedies · Horses · Trinidad and Tobago · British Columbia

4.1 Background

In Trinidad and Tobago, horses are typically kept for racing. The Trinidad & Tobago Racing Authority operates the Santa Rosa Park (horse racing) at O'Meara Road in Arima. There has been a steady decline in the racing industry in Trinidad. The number of broodmares registered to stud in 2008 was 37, compared to 7 in 2018. Earnings by the industry have therefore experienced a dramatic decline over the past 10 years. There are currently 44 registered trainers and 156 registered grooms. Forty-three percent of equine farms in British Columbia (BC) gross below $10,000. From 2011 to 2016, there was a 17.5% drop in the number of farms with horses or ponies to 39,164 agricultural operations. Over the same period, the number of ponies and horses declined by 25.7% to 291,561, reportedly due to increasing costs (Rostami 2017). Horse farms are more likely to have a female operator (19.1%) than other farm operations (Rostami 2017). Horses are mainly kept as companion animals and for racing. There are a few horses that are kept as draft horses.

Racehorses have frequent bouts of intense exercise which produces articular inflammation and cartilage turnover that can be seen 8 h after a race or other intense exercise in the form of higher concentrations of nitric oxide and prostaglandin E_2 (MacNicol et al. 2018).

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Ranch, riding and companion horses would also show the effects of short periods of intense exercise or longer periods of sustain exercise such as trail riding or herding cattle.

Racehorses may also need treatment for recurrent airway obstruction (chronic obstructive pulmonary disease) which may result in missed training (Pearson et al. 2007).

4.2 Methods

In the study in BC conducted in 2018, respondents from the previous study (Lans et al. 2006) were contacted. In addition, horse owners who CL met professionally in the last 4 years were also interviewed. As most of the key respondents who provided information for the study conducted in Trinidad between 2000 and 2003 had either passed away or were no longer in the industry, KG and CS visited the race track to conduct interviews. Persons selected were identified by racehorse trainers and owners as regularly practicing the use of herbal remedies. Information was obtained from nine grooms and three trainers. Participants were asked if they knew about plants used in the industry. Specific questions on the use for ailments broadly classified as respiratory infections, bleeders, cuts, ocular injuries, lameness, dermatological conditions, performance enhancing and gastrointestinal and reproductive issues. Participants were interviewed individually in the presence of the horse that was under their care. They were asked to demonstrate how certain medications were applied. Information was recorded as the participant was allowed to speak freely, and if consent was given, a photo or video was taken during the demonstration. In addition, if available, the plant was collected from the respondent. One Canadian racehorse owner worked at one of the five horse racing tracks in BC. Three BC respondents offered boarding, training and riding lessons. The others owned horses for riding.

4.3 Results

All respondents from Trinidad stated that most of the treatments for routine preventive care and injuries were commercial pharmaceutical products which could be obtained onsite. These preparations included dewormers, anti-inflammatory products, multivitamin tonics and poultices. The majority of the respondents reported using the similar plants for the pharmaceutical purposes as was reported previously.

4.3.1 Commercial Products

One respondent from Trinidad reported a herbal product LungProof® from a website called HorsePower herbs for respiratory problems and epistaxis as it strengthens the capillaries and aids the respiratory tract to repair weakened airways. The ingredients of this commercial product include a mixture of herbs such as mullein, *Echinacea purpurea*, elecampane root, lobelia, shepherd's purse, sage and lungwort.

https://www.horsepowerherbs.com/articles/equine-horse-dietary-supplments_happyhorsecomplete.htm

Standard remedies were also mixed with plants. Common products used were Epsom salts (magnesium sulphate), salt, bicarbonate of soda, beer, sugar, Vicks VapoRub® and kerosene.

1. A blanket soaked in warm water and Epsom salts was applied to a clean horse to alleviate dry coat.
2. Bicarbonate of soda and Epsom salts was added to the feed every day.
3. Epsom salts was used to eliminate fatigue. Commercial alcoholic beverages were also used.
4. Guinness® stout was used with aloe vera as a tonic to improve performance. Garlic, together with cod liver oil, was also used as a tonic as well as treatment of colic.
5. Hot Carib® lager beer was used for colic.
6. Vicks VapoRub® was placed inside the horse's nostril for respiratory problems.
7. Colic was treated with burnt kerosene.
8. Head colds were treated with a salt solution syringed into the nostril.

Commercial dewormers and a commercial preparation for bleeding were widely used.

4.3.2 Ocular Remedies

To treat eye infections, sugar was ground up very fine and made into a powder. This was then dissolved when placed into the mouth and spat into the eye of the horse. This was done twice daily until the issue resolved.

4.3.3 Injuries

Commercial reparations such as Absorbine® and Red Udder® ointment were used especially for tendon knee injuries. Red udder ointment consists of phenol, eucalyptol, methyl salicylate and camphor in an emollient base. Other remedies included ice, glycerin, Epsom salts and iodine.

A mixture of honey, garlic and cod liver oil was given to the horse to aid in lubrication of the joints. Additionally aloes and blue wound spray were used to treat injuries and wounds.

4.3.4 Nutrition

Speed weed (local alfalfa), Spanish needle (*Bidens pilosa*), peanut husks (*Arachis hypogaea* L.), lucunto (*Ischaemum timorense*), bull grass (*Paspalum fasciculatum*), Pangola grass (*Digitaria eriantha* Steud. [Poaceae]), bamboo (*Bambusa vulgaris*), elephant grass (*Pennisetum purpureum*), carrots and apples were commonly used to improve nutrition.

If horses were off food or eating poorly, the following practices were recorded. These were added to the food:

1. Crushed sugar cane.
2. Molasses was given in either the water or the food.
3. Linseed or barley was cooked properly for at least 20 minutes and added to the food.
4. Honey, cod liver oil, garlic, wheat germ oil, shark oil and coconut oil assisted in producing a shiny coat.

4.3.5 Stress

Companion animals were placed in stalls to control stall walking – usually a sheep or a fowl.

Datura pod (*Datura stramonium*), which can cause hallucination, has been reported to be used to calm a horse.

4.3.6 Cultural Practices

Different cultural practices were reported. These included the use of blue ribbons which were hung in the stall to ward off evil eye (envy). The gum of asafoetida was also used to ward off evil as well to alleviate colic. Other sacred plants such as the tulsie (*Ocimum tenuiflorum* or *O. gratissimum*) were used for protection.

The smoke emitted from burning ants' or termites' (*Nasutitermes corniger*) nests mixed with menthol, eucalyptus oil, bay leaf, glycerin or Epsom salts can be used to treat head cold. The horse is allowed to inhale the smoke (Fig. 4.1).

Bee comb (honey comb) – Respondents recommended using a small amount to condition the horse as it is thought to be very potent.

Fig. 4.1 Termite nest preparation and application

4.3.7 Broodmares

A couple of different mixtures were used to prepare brood mares for breeding or assist in cleaning out the horse. These include:

1. A mixture of aloe, saffron/turmeric and bicarbonate of soda. This mixture was inserted into the vagina with a pump for horses with metritis.
2. Gum of asafoetida, aloe and Guinness® to improve condition or a mixture of Guinness® stout, linseed and barley was given together with pelleted feed.
3. A hot Guinness® was given to broodmares close to the date of parturition as it is believed to decrease bleeding associated with this process.

4.3.8 Insect Repellents

Citronella oil (*Pelargonium citrosum*), bay leaf (*Pimenta racemosa*) and neem (*Azadirachta indica*) were used as insect repellents. The latter was used primarily to control ants. The plants were dried and hung in the stall to repel insects.

4.3.9 Poultices

A variety of different materials were used as poultices. These included clay with aloe, blue soap, bran, cow dung, flour, sugar of lead, Epsom® salts, river clay, Absorbine® and wonder of the world leaves (*Kolanchoe pinnata*).

To treat abscesses, aloe can be used with Epsom® salts, ratchet (*Opuntia cochenillifera*) and "hardi" (turmeric) to draw out thorns and stones stuck in the hoof. Alternatively the hoof can be soaked in Epsom® salts and warm water. For problems with the tendons, the brine collected from salted pig tails (human food) is allowed to ferment and then used to soak the legs of the horse.

4.3.10 Illegal Practices

There were some practices that were considered to be unethical. These included placing cow itch (pods of a tropical vine, *Mucuna pruriens*) in the anus of the horse. This causes severe itching, and it is believed to enhance the performance of the horse. The effects of cow itch can be reversed by using molasses in the area which the cow itch was placed. Another illegal practice that was discovered was the use of marijuana (cannabis) on nervous horses. The horse was allowed to inhale the smoke which had a calming effect on them (Table 4.1).

4.3.11 Canada

Products from two websites were being used. One website was called "Riva's Remedies", while the other one was called "Greenhawk". One respondent had her own website called "Wisdom of the Herd".

Turmeric pills were suggested for inflammation.

Ancient remedies were also used such as honey and cobwebs for wounds.

A racehorse owner used horse-edible charcoal for nervous stomachs and still used a comfrey-based liniment for muscle recovery. The formulas for the comfrey liniment are below:

1. Comfrey leaves (as many as you can get). Put the leaves in a crock pot on low, crack lid, do not boil. Leave it on low overnight. Next day, the comfrey decoction will be dark like coke. Dilute this decoction with witch hazel or rubbing alcohol. Put it on your hand and rub on.
2. Comfrey root (1/2 lb) in 300 ml vodka and 800.25 ml grapeseed oil. Put in crock pot for 24 hours. This makes a base ointment which can be diluted in half with rubbing alcohol or witch hazel.
3. Comfrey root. ¼ bottle with the rest of vodka. Put it under the sun for 2 weeks, shake it regularly.

Table 4.1 Practices obtained from interviews at the Santa Rosa race track

Plants used for muscle soreness and tendon problems		
Plant	Muscle soreness	Tendon problems
Bay leaf *Pimenta racemosa*	Boil it and bathe them with it early in the morning. Observe the horse to determine if to repeat	
Castor oil *Ricinus communis* plant leaf		Roll a bottle over the leaves to destroy the vein – Wrap around the area after warming slightly and then bandage for 3–4 days. Remove in the morning and repeat
Wonder of the world leaf (*Kalanchoe pinnata*) *Bryophyllum pinnatum*	Wonder of the world leaf is used the same way as castor oil leaf. Wonder of the world, castor oil leaf (heat over a lighted candle). This is used close to race time to draw out wear and tear	Wonder of the world with clay, paper and plastic for tendon injuries. Also used the same as castor leaf. Wonder of the world with clay. Put on clay, wonder of the world and wrap with a bandage. Wonder of the world sets quickly.
Ratchet (*Opuntia cochenillifera*) copra		Soft candle, ratchet and wonder of the world

Plants used for injuries	
Plant	Injury
Chadon Beni leaf *Eryngium foetidum*	This is used for kick injuries close to the eye. Two leaves are boiled in water and allowed to draw. When it is cool, wash the eye with it and leave it. In 3–4 days clean the eye and wound
Wonder of the world leaf *Kalanchoe pinnata*	Also used as a poultice. Warm the leaf, roll to destroy the veins, apply home-made paste on leaf and wrap the affected area
Cocoa *Theobroma cacao*	Young cocoa pods about 3 inches long are used for deep cuts which cannot heal and unable to suture

Plants used as tonics	
Plant	Tonic
Aloes *Aloe vera*	Aloes and 2 Guinness stout (clean out) are given once per day for 2–3 weeks
Bamboo X2 *Bambusa vulgaris*	Leaves are added to the feed – Change of food (taste) before racing
Ratchet *Opuntia cochenillifera*	When horse is not sweating, use ratchet and copra. Grate the whole copra and mix with molasses. Give to the horse once per day to clean out the pores
Copra (dried and roasted coconut meat)	
Speed weed (local alfalfa)	Performance – Speed weed. Give this on race week.
Obi seed *Cola acuminata*	"Clean out blood"

(continued)

Table 4.1 (continued)

Plants used to condition coats	
Plant	Coat condition
Noni *Morinda citrifolia*	Use for dull coat, dry coat
	Collect the juices that drain out of the rotting fruits and give up to 60 cc/day for 5 days
Black sage *Cordia curassavica*	Black sage leaves are picked green and made like a broom (wiz; Fig. 4.2). This can be used every other day (3 times per week) to rub on them – Half dry helps to shine coat. Also used with Guinea grass (elephant grass) (x3). Add baby oil (x1)
Caraili *Momordica charantia*	Caraili leaf bush (wiz), elephant grass (wiz) – Use one or the other, but not both together (x3). This can be used with baby oil. It is indicated for horses with rashes and irritated skin as a brush will irritate the horse's skin

Plants used for coughs and colds	
Plant	Colds, coughs
Garlic *Allium sativum*	Garlic, coconut and turmeric are used to treat cough. Mix and administer twice per day. Depending on severity of cough, give for approx. 1 week
Grapefruit juice – Citrus growers brand *Citrus paradisi*	Grapefruit for colds
Fever grass *Cymbopogon citratus*	Fever
L'herbe a pique *Neurolaena lobata*	Draw and mix with honey; expel before dry off totally
Elephant grass *Pennisetum purpureum*	When recovering from tick fever, use elephant grass, molasses and Redglo™ tonic

Plants used for nosebleeds	
Plant	Nosebleeds
Bois canot *Cecropia peltata*	Bois canot branches are crushed and added to the feed
"Hardi"/turmeric *Curcuma longa*	1. Unpeeled. Blend with wheat germ or cod liver oil to form a paste. Give once per day for 1–2 weeks
	2. "Hardi"-turmeric for bleeders. Boil a small piece. Give horse for 5 days (about 20 cc)
	3. "Hardi"-blend with cod liver oil and honey. Add to the feed
Aloes	Mix together aloes, ginger and lime. Place in nostril every day for 3 days
Aloe vera	Ginger and aloes. Mix together and can last for 3 days. Put in mouth 10 cc at a time till 1 oz
Grapefruit juice- citrus growers brand *Citrus paradisi*	Bleeders – Rub lime and salt in mouth. Used especially for horses that will be expelled as bleeding is going on for too long
	Grapefruit juice for nosebleeds. Tie the head for 15 minutes, take 40 ml and squirt it up the nostrils of the horses (20 ml each)

Fig. 4.2 Application of a wiz

The use of diatomaceous earth for parasites was not considered safe for the gastric lining.

A respondent claimed to have tried a variety of herbs but with no positive results. Another one was retired and no longer treating animals. One respondent had contacted me several years ago about producing a herbal bronchial formula that was given to a client's racehorses a few days before they raced, but had no new information.

Feisty Mare™ was being used to calm horses, regulate hormone production and help horses focus. It was bought from the Greenhawk website but is actually manufactured by Selected BioProducts (Herbs for Horses) in Guelph, Canada (Table 4.2).

Table 4.2 Some of Riva's equine herbal and homeopathic remedies

Condition	Herbal constituents
Colds	Homeopathic – "*Aconitum*, *Argentum m*, *Baptisia*, *Bryonia*, *Drosera*, *Eupatorium*, influenzinum"
Coughs	"Horehound, fenugreek, mullein leaf, wild cherry"
Anxiety	Homeopathic – "*Aconitum*, *Arsenicum*, chamomilla, ignatia, *Passiflora*, phosphorus; black cohosh, chamomile, lemon balm, passion flower"
Arthritis	"Birch bark, black cohosh, burdock root, *Yucca*"
Colic	"*Aconitum*, *Argentum nitricum*, chamomilla, *Colchicum*, colocynthis, *Lycopodium*, mag phos, nux-vomica, *Veratrum album*"; "caraway, catnip, fennel, fenugreek, peppermint leaf"
Cribbing, ulcers	"*Lactobacillus casei*, *Lactobacillus* acidophilus, *Bifido bifidum*, fructo-oligosaccharides, ascorbic acid"
Diarrhoea	"*Aloe*, China (*Cinchona* officinalis), Natrum-mur, *Podophyllum*, silicea"; "bentonite clay, chamomile, Irish moss, slippery elm"
Heaves, allergies	"Alder, *Thuja*, thymuline"
Hooves	"Boneset, birch bark, chamomile, cayenne, oatstraw"
Hormonal mares	"Black cohosh, blessed thistle, chamomile, wild yam root"; evening primrose oil
Immunity	"*Astragalus*, fennel, milk thistle, rosehips, spirulina, sea buckthorn"
Infections	"*Lachesis*, Hepar sulph, Mercurius v, silicea". External use – "Goldenseal, pure tea tree oil, light olive oil"
Injuries	"*Arnica montana*, *Bryonia*, *Hypericum*, Rhus tox, *Ruta graveolens*, *Symphytum*"
Liver conditions	"Dandelion root, milk thistle"
Equine metabolic syndrome	"Alfalfa, insulin, *Juniperus*, *Syzygium*"
Endocrine system support	"Ashwagandha, chaste berry, kelp, liquorice root, raspberry leaf"
Skin	"Goldenseal, pure tea tree oil, light olive oil"
Adrenal burnout, fatigue	"Ashwagandha, chaste berry, kelp, liquorice root, raspberry leaf"
Stamina and energy	"Chia seeds, oatstraw, Siberian ginseng, spirulina"
Circulation, laminitis, tissue repair	"Pine bark extract"
Metabolic support	"Agnus castus"

4.4 Discussion

4.4.1 Trinidad and Tobago

A review by Maan et al. (2018) describes the wound healing properties of *Aloe vera*. The active compounds include amino acids and minerals such as copper, calcium, chromium, iron, magnesium, potassium, sodium and zinc that contribute to wound healing. *Aloe vera* stimulates the production of antibodies and releases growth factors.

Wounds treated with *Aloe vera* heal without scars because the healing process is stimulated at the deepest layers of the skin.

A case of horse poisoning in Brazil was attributed to feeding large amounts of bamboo (*Bambusa vulgaris*) (15 kg/day mature leaves for 30 days or 3 kg/day young leaves for 60 days) (Barbosa et al. 2006). Death was attributed to neurological disease because no hydrocyanic acid was found in the leaves. Bamboo (*Bambusa vulgaris*) contains a "crude protein content of 10.1%, phosphorus 86.0 mg/100 g, iron 13.4 mg/100 g, vitamin B10 1 mg/100 g, vitamin B2 2.54 mg/100 g and carotene 12.32 mg/100 g" (Lodhi et al. 2016).

Cecropia peltata had a positive-inotropic effect on isolated atria but also increased the troponin C contents of the bathing solution harmed the myocytes (Bipat et al. 2016). The plant produces glycogen and starch (Bischof et al. 2013). Active compounds are steroids and amino acids, and studies have supported the use of *Cecropia peltata* for wound healing after oral and topical administration in a rat model (Rivera-Mondragón et al. 2017).

Cola acuminata seeds contain the purine alkaloids theobromine and caffeine and the polyphenols epicatechin and catechin (Ishola et al. 2018).

Cordia curassavica has been investigated for its antinociceptive, analgesic and anti-inflammatory activity (Matias et al. 2015). Artemitin may be one of the active compounds.

Curcuma longa has curcuminoids with anti-influenza properties (Dao et al. 2012).

Cymbopogon citratus is considered safe for consumption and has antimalarial activity (Chukwuocha et al. 2016). Anti-inflammatory and healing activity is attributed to apigenin glycosides, geraniol, cassiaoccidentalin B, cyranoside, carlinoside, condensed tannins and luteolin (Costa et al. 2016; Venzon et al. 2018).

Datura species have caused fatal and non-fatal poisoning (impaction colic) in horses when incorporated into hay, or when the seed contaminates grain (Gerber et al. 2006). The tropane alkaloids in the plant include scopolamine, hyoscine, hyoscyamine and atropine (Benítez et al. 2018). Hyoscyamine and atropine can cross the blood-brain barrier and affect the nervous system. Hyoscine has such strong depression, hypnotics and amnesia causing properties that it has been used for criminal activity (Benítez et al. 2018). Old textbooks listed scopolamine as a soporific in humans and dogs, but it is said to produce hallucination and excitability in horses (Gerber et al. 2006). Ishola et al. (2018) review the literature of scopolamine and report that it has an amnesic effect and impairs learning and 'short-term retention of spatial memory tasks'. No clinical symptoms were seen in horses with a urine concentration of scopolamine under 150 ng/mL (Brewer et al. 2014). Hong Kong sets a limit on the alkaloid content in the feed of racing horses at 30 ng/g for scopolamine and 100 ng/g for atropine (Brewer et al. 2014). Louisiana has a threshold of 75 ng/mL in urine for scopolamine (consistent with accidental environmental contamination in hay), and Europe has proposed a limit of 30 ng/mL for atropine and scopolamine. Horses in the USA with scopolamine in their urine have had their prize earnings confiscated, and their trainers have been fined or otherwise penalized (Brewer et al. 2014).

Eryngium foetidum contains carotene, calcium, eryngial, essential oils, iron, proteins, riboflavin and vitamins A, B and C. It has analgesic, antibacterial and anti-inflammatory activity (Kouitcheu et al. 2016).

Momordica charantia contains hundreds of bioactive compounds including alkaloids, amino acids, fatty acids, polysaccharides, protein, triterpenoids and trace elements (Zhang et al. 2016).

Neurolaena lobata contains germacranolide and furanoheliangolide sesquiterpene lactones, including lobatin B, with anti-inflammatory, analgesic and anti-viral activity (McKinnon et al. 2014). Anti-inflammatory activity is attributed to the inhibition of nuclear factor-kB and TNF-alpha production and the production of inflammatory cytokines, activities that do not produce unwanted side effects.

Ricinus communis contains ricinoleic acid (85–90% of triglycerides). The seed extract has antibacterial properties as well as anti-inflammatory and analgesic effects (Totaro et al. 2014; Gandra et al. 2017).

Cocoa pod husk (*Theobroma cacao*) contains pectin with a high acetyl content. Pectins play a positive role on humoral and cellular immunity (Amorim et al. 2016). The pectin from cocoa pod husks can form a gel (Vriesmann and Petkowicz 2013). The husks also contain phenolic compounds such as gallic acid, coumaric and protocatechuic acids, catechin, (−)-epicatechin and quercetin (Valadez-Carmona et al. 2017).

4.4.2 Canada

The use of comfrey and the other herbs matches the human use in Canada and in other countries. For example, 179 of 239 UK members of the Association of Master Herbalists, the College of Practitioners of Phytotherapy and the National Institute of Medical Herbalists reported using comfrey creams for ligament, muscle and tendon problems (Frost et al. 2014). Some supplements given to horses were reviewed by Williams and Lamprecht (2008). They noted that there are saponins acting like steroids in yucca with anti-spasmodic effects, antioxidant effects and anti-inflammatory activity.

Feisty Mare™ is produced by Selected BioProducts in dry or liquid forms. In a 30 g dose (1 scoop) both formulations contain antioxidant blend (amount not provided), aniseed (3.0 g), chamomile (9.0 g), chasteberry (7.5 g), lemon balm (7.5 g) and thyme (3.0 g).

The aniseed and chamomile (*Pimpinella anisum, Thymus vulgaris*, *Matricaria chamomilla*) in Feisty Mare have an estrogenic effect which is not solely due to anethole (Tabanca et al. 2004; Kassi et al. 2004; Noh et al. 2016). The estrogenic activity of *Vitex* has been documented by several authors (Powers and Setzer 2015). Lemon balm (*Melissa officinalis*) has anti-inflammatory activity attributed to terpenoids, flavonoids and rosmarinic acid (Hosseini et al. 2017).

There are two principals involved in Selected BioProducts located in Guelph, Canada. One of them has conducted research on herbs for horses. In her most recent publication, a mint species (*Mentha spicata*) which produces 20 times the normal amount of rosmarinic acid than other mint species was tested together with its metabolites, coumaric acid, ferulic acid and caffeic acid, and found to have anti-inflammatory activity in an animal model of cartilage inflammation (Pearson et al. 2012). An earlier study by Pearson et al. (2007) examined a Selected BioProducts herbal compound called Breathe™ that reduced the respiratory rate in contrast to the placebo group, increased the amount of macrophages and reduced the amount of neutrophils. The compound contained aniseed, boneset, fennel, garlic, liquorice, thyme and white horehound. The authors attributed the reduced respiratory rate to quercetin and to volatile oils.

A respondent claimed that a veterinarian in Alberta has formulated a comfrey-based liniment for those people who do not want to make their own. Irvine Saddles in Alberta sells a liniment called Extreme Comfort™ that contains comfrey and menthol, and its suggested uses include stocked up lower limbs, sore backs, pulled muscles, strained tendons, bucked shins, pain associated with joint and bone diseases as well as pain due to soft tissue and muscle injuries.

Riva's Remedies contained papaya leaf in a formula for diarrhoea in horses. Papaya latex containing cysteine proteinases reduced the motility of the equine cestode *Anoplocephala perfoliata* in vitro, causing their death (Mansur et al. 2016).

A hormonal treatment from Riva's Remedies contains evening primrose oil. A feeding trial found that supplementation with 30 ml of evening primrose oil had an effect on hoof growth only in 4–8 weeks of the trial (Reilly et al. 1998).

4.5 Conclusion

The use of herbal remedies continues to be apparent in the racehorse industry in Trinidad. Commercial herbal remedies have entered the market and may be finding its place for use in mainstream veterinary medicine. It was encouraging to discover that the knowledge of herbal remedies was still alive although it was more of a niche-type practice. The Canadian sample was very small, so no conclusions can properly be drawn.

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Chapter 5
Plants for Controlling Parasites in Goats

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Keywords Goats · Parasites · Gastrointestinal · External parasites · Indigenous knowledge systems · Ethnoveterinary medicine · Plant remedies

5.1 Introduction

Of the many farmed livestock species, goats are one of the most exploited species, due to their resilience as demonstrated by their ability to thrive under harsh environmental conditions characterized by high ambient temperatures, low humidity and restricted feed availability (Zvinorova et al. 2016). Goats contribute greatly to the livelihoods of communities through the provision of nutrient-dense foods for human consumption, in the form of chevon (meat) and milk, products such as fibre and skins, manure and a "ready-to-use rural-household bank" (Anaeto et al. 2010; Dube et al. 2016; Babiker et al. 2017). This translates into improved socio-economic status of communities that farm them. In developing countries where unreliable veterinary services exist and where poor management (inadequate feed, poor parasite and disease control and inappropriate housing) is the "norm", external and internal parasite infestations compromise goat productivity through stress induced by parasite-mediated skin irritation, anaemia and other diseases that ultimately lead to death of

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the animals (Molefe et al. 2012). Importantly, this parasite-induced stress also leads to poor fertility that manifests as reduced oestrus activity and early embryonic death and increased early post-partum kid deaths, all which negatively impact reproductive capacity (Dobson et al. 2012; Papadopoulos et al. 2013). External parasites like mange mites, ticks, biting and blood-sucking flies (tabanids) and internal parasites particularly *Haemonchus contortus* and *Fasciola hepatica* are more common in developing countries where they compromise goat health and reduce productivity (Roeber et al. 2013; Molina-Hernández et al. 2015; Sargison 2016). In view of the parasites' devastating effects on goat welfare and productivity, parasite control is therefore of utmost importance.

The use of conventional pharmacological agents in the form of acaricides and anthelmintics to control external and internal parasites in goats is characterized by the development of drug resistance within the parasite populations (Zeryehun 2012; Nyahangare et al. 2015; Sargison 2016). Environmental and animal product contamination that stems from the release of drug residues into the environment ultimately results in pollution of the environment. Over and above the problem of resistance and environmental contamination associated with the use of conventional acaricides and anthelmintics, these pharmacological agents are costly and relatively inaccessible (Ngeh et al. 2007; Lem et al. 2014) especially in rural farming communities of developing countries which also are saddled with inadequate and inconsistent veterinary service provision (Kebede et al. 2014).

The use of plant-derived ethnoveterinary medicines in the management of the parasite burden in goats and other livestock is on the increase (Soetan et al. 2011; Carvalho et al. 2012; Kommuru et al. 2014). The relative ease of accessibility, lower cost compared to conventional pharmacological agents and acceptability (they are deemed safer to the environment and animal products) are some of the factors that have provided a fertile ground for the increase in the use of plant-derived ethnoveterinary medicines (SriBalaji and Chakravarthi 2010; Wabo et al. 2010). The use of ethnoveterinary medicines and the transmission of information pertaining to their use are part of the indigenous knowledge systems (IKS). In most developing countries, IKS is transmitted orally through word of mouth with no written records (Sanhokwe et al. 2016) which are amenable to distortions and/or loss of information with time. In order to create a data bank of ethnoveterinary medicines and practices in use, there is a dire need to profile and test in vitro and in vivo and to document results of work pertaining to plant-derived ethnoveterinary medicines. Such an approach over and above generating an important data bank on IKS helps preserve such IKS as intellectual property which can be tapped into in the process of developing sustainable pharmacological agents (drugs) for commercial use in the livestock industry. This chapter seeks to bring to the fore the IKS pertaining to the use ethnoveterinary medicines and research around the subject of ethnoveterinary medicine with an ultimate aim of creating an area of research where IKS in livestock health interfaces with conventional knowledge and value systems.

5.2 Gastrointestinal Parasitism in Goats

Helminthiasis, infestation with or diseases caused by parasitic worms [cestodes (tapeworms), trematodes (flukes) and nematodes (roundworms)], is one of the predominant challenges to livestock (goat) productivity in developing countries (Mungube et al. 2006; Vatta and Lindberg 2006). For example, Kenya and South Africa experience between US$ 26 million and US$ 45 million annual losses from nematode infections (Anonymous 1999; Krecek and Waller 2006). A multiplicity of factors, among them poor management (nutritionally inadequate feeds, poor housing, poor or lack of parasite control and disease control), and favourable environments, for example, warm temperatures that promote parasite multiplication (Di Cerbo et al. 2010; Hassan et al. 2011; Belina et al. 2017), are the major causes of helminthiasis. Maphosa (2009) contended that in tropical areas, the management practice whereby ruminant livestock (goats included) graze year-round results in exposure to continuous infection with parasites. Such continuous exposure to infection by parasites causes lower goat productivity that translates to considerable economic losses (Paddock 2010; Roeber et al. 2013). Parasite infestations that result in subclinical infections lead to prolonged production losses (Kumar et al. 2013; Nasrullah et al. 2014) with profound economic outcomes. The production losses stem from compromised weight gains, feed utilization, reproduction efficiency and meat and milk production (Qamar et al. 2011). The production losses to the goat enterprise due to parasite infestation are aggravated by the cost of anthelmintic drugs required to control the infections (Molina-Hernández et al. 2015).

In goats *Trichostrongylus* species, *Trichuris* species, *Bunostomum* species, *Haemonchus* species, *Oesophagostomum* species and *Ostertagia* species are the major causes of helminthiasis (Kumar et al. 2013). Of the many worm species that cause helminthiasis, *Haemonchus contortus* (barber's pole worm) is the most pathogenic nematode that severely compromises goat productivity and leads to loss through death (Roeber et al. 2013; Villarroel 2013). Infestation with *Haemonchus contortus*, especially in kids, is characterized by high mortalities (Adhikari et al. 2017). This nematode parasite sucks blood leading to loss of blood which manifests as severe anaemia (Roeber et al. 2013).

5.3 External Parasitism in Goats

External parasites such as lice, ticks, fleas and mange mites cause mechanical tissue damage, irritation, inflammation, hypersensitivity, abscesses, weight loss, lameness, anaemia and death in severely infested animals (Beyecha et al. 2014; Seyoum et al. 2015). Therefore, external parasitism in goats is of economic importance as it reduces meat and milk yield and results in losses due to culling and cost of treatment and prevention of parasites. They are also responsible for great preslaughter skin defects, resulting in downgrading and rejection of skins (Mersha 2013; Yacob 2014). Furthermore, external parasites are of zoonotic importance due to their blood-sucking habit, causing the transmission of diseases from animals to animals and from animals to humans (Mersha 2013).

The spread of lice, tick, flea and mite infestations is enhanced by unhygienic conditions, increased population density, poor housing, high temperatures and humidity (Pandita and Ram 1990; Oberem and Schröder 1993). Lice are small wingless ectoparasites that have stout legs and claws which enable them to cling to the host (Wall and Shearer 1997). Lice infestation in goats is a major concern worldwide (Iqbal et al. 2014). The biting lice (*Damalinia caprae*) and the sucking lice (*Linognathus africanus*) are the two most common parasites affecting goats (Giri et al. 2013). The major clinical manifestations of lice infestation in goats are ascribed to the irritation and hypersensitivity reactions to the antigens in the saliva of the lice (Iqbal et al. 2018).

Ticks are one of the most economically important parasites of goats. About 35 tick species are found in Southern Africa (Parola and Raoult 2001). Ticks also cause tick worry by irritating goats and causing discomfort leading to severe energy loss and weight. Hunter (2004) noted that reduced growth in tick-infested goats is due to the presence of toxins in the saliva of ticks. The toxins in saliva affect the entire host's organs which later cause paralysis (Kahn 2006). Severe blood loss which eventually leads to anaemia has been reported in tick-infested goats. Ticks are also vectors which are responsible for transmitting tick-borne diseases such as theileriosis, babesiosis, anaplasmosis and heartwater (Plumb 2008). The common tick species affecting goats include *Demodex caprae*, *Ixodes holocyclus*, *Rhipicephalus sanguineus*, *Rhipicephalus microplus* and *Boophilus decoloratus* (Papadopoulos et al. 1996; Plumb 2008).

Fleas are obligate parasites that affect mammals and birds. In South Africa, about 100 flea species are only responsible for parasitizing domestic livestock (McDermott et al. 2000). High temperatures and humidity favour proliferation of fleas. The most common flea species affecting goats are *Ctenocephalides felis* and *Ctenocephalides canis* (Rahbari et al. 2008). Fleas have been reported to suck blood, therefore causing anaemia and eventually death in heavy infestations (Salam et al. 2009). They also cause severe irritation, and, in some cases, their bites open severe wounds which then become an entry site for other secondary infection.

Mange mite is one of the most important diseases that dreadfully damages small ruminant skins and hides. Mites are very tiny external parasites that burrow beneath the skin surface of hosts and inject subcutaneous secretions which damage the skin (Curtis 2004; Nejash 2013). Mange mites feed on blood, lymph and skin debris of the host (Nejash 2013). The species more commonly found on goats include *Demodex caprae* (goat follicle mite), *Sarcoptes scabiei* (scabies mite), *Psoroptes cuniculi* (psoroptic ear mite) and *Chorioptes bovis* (chorioptic scab mite) (Fentanew et al. 2015).

5.4 Conventional Methods of Controlling Parasites

Under intensive goat production, conventional anthelmintic drugs are routinely used to control internal parasites (Kumar et al. 2013), while in small-scale goat production, due to the high cost and inaccessibility, the use of these conventional drugs to control worms is marginal, non-strategic and characterized by the application of inadequate doses (Shalaby 2013). In the small-scale goat farming sector, worm control using conventional drugs is done when the animals show definite signs of infestation/infection, by which time productivity is already compromised. While it is the norm to practice strategic worm control by dosing every 3–4 weeks, research points to greater benefit (a reduction in pasture infectivity and worm burden) being realized when dosing against internal parasites is done just before and after rain (Shalaby 2013).

As predicted by van Wyk (1990) two decades ago, the routine use of anthelmintic drugs has led to the problem of parasite resistance. The resistance to conventional anthelmintic drugs has become a problem globally that is significantly impacting goat productivity (Fairweather 2011; Dalton et al. 2013; Kotze et al. 2014). In Denmark, notable examples are resistance by *Trichostrongylus* and *Ostertagia* worm species to thiabendazole and levamisole (Maingi et al. 1996). Terrill et al. (2001) contend that in the USA nematode worms that infect the GIT of goats have developed resistance against ivermectin, albendazole and levamisole, while in South Africa *Haemonchus* spp. have developed resistance against albendazole, levamisole and ivermectin (Tsotetsi et al. 2013; Van Wyk et al. 1999; Vatta et al. 2001). High levels of resistance to benzimidazoles by small ruminant internal parasites have been reported in Malaysia (Dorny et al. 1994). The cited examples of resistance point to ample evidence for multiple resistances encompassing all broad-spectrum anthelmintics.

Commercially available chemical acaricides have been used extensively worldwide to control external parasites. Ticks and mites are usually controlled by acaricides which are applied in different ways. Acaricides can be applied by dipping, pour on and spraying (Rajput et al. 2006). Fleas are controlled by insecticides which are formulated as dust sprays or fine sprays (Boone et al. 2001). Anti-tick vaccines have also been developed and are environmentally friendly (Uilenberg 2005). Ivermectin can be used to control parasites such as ticks, fleas and mites. However, in many developing countries, the availability of these commercial acaricides may be inconsistent or completely unavailable (Scialabba 2000). The escalating costs of acaricides, environmental pollution and residues in animal products are also challenges stemming from the use of acaricides (Graf et al. 2004). Commercial drugs also tend to harm non-target organisms (Uilenberg 2005). The development of widespread host resistance is another problem which makes parasite control difficult (Graf et al. 2004; McNair 2015). For example, *Boophilus* ticks are resistant to organophosphate carbonates (Mekonnen 1998).

The high cost, unavailability, inaccessibility, inappropriate and inaccurate use, development of resistance and drug-induced environmental and product contamination associated with the use of conventional acaricidal and anthelmintic drugs to control parasites in goats result in a dire need to search for and develop alternatives that are more natural and whose use is sustainable in the long term.

5.5 Plant-Derived Ethnoveterinary Medicaments for Controlling Parasites

Plant-derived ethnoveterinary medicines have been and continue to be used as acaricidal and anthelmintic drugs in the developed world. Due to the emergence of parasites that are resistant to conventional acaricidal and anthelmintic drugs, there is renewed interest in using plant-derived ethnoveterinary medicaments as alternatives to conventional drugs in the control of parasites in goats (Kumar et al. 2011; Muthee et al. 2011; Burke et al. 2012; Juliet et al. 2012; Koné et al. 2012).

In Katanga province, the Democratic Republic of Congo, nine plant species commonly used to treat gastrointestinal parasitic infections were identified. Among these plants, *Vitex thomasii* (Kikoto muchi), family name Verbenaceae, is commonly used (Embeya et al. 2014). Djoueche et al. (2011) report *Anogeissus leiocarpus* and *Gardenia ternifolia* to be among the plants used to treat intestinal worms in sheep and goats in the Bénoué, Cameroon. In Palestine, 140 plant species with health beneficial medicinal activities are noted to be used in the preparation of ethnoveterinary medicines utilized in treating several livestock diseases including gastrointestinal infections (Ali-Shtayeh et al. 2016). *Trachyspermum ammi*, *Amomum subulatum*, *Punica granatum*, *Nicotiana tabacum*, *Acacia nilotica* and *Withania coagulans* are among the many plants from which ethnoveterinary medicaments are prepared and used successfully in the control of worm infestations (Badar et al. 2017). In Kenya, *Aloe latifolia*, *Azadirachta indica*, *Commiphora eminii*, *Crotalaria laburnifolia*, *Kigelia africana*, *Olea europaea*, *Solanum incanum* and *Warburgia ugandensis* are used by the Meru tribe as anthelmintics (Gakuubi and Wanzala 2012). In South Africa, livestock farmers have a long history of using plant-derived preparations for animal health care (Dold and Cocks 2001; McGaw and Eloff 2005) largely due to the broad diversity of plants with health beneficial activities for livestock health management (Table 5.1). *Aloe ferox*, *Aloe arborescens*, *Acokanthera oppositifolia*, *Elephantorrhiza elephantina*, *Albuca setosa*, *Centella coriacea*, *Bulbine latifolia*, *Teucrium trifidum*, *Strychnos henningsii*, *Leonotis leonurus*, *Cleome gynandra*, *Maerua angolensis* and *Monsonia angustifolia* are among the plants used to control gastrointestinal parasites in South Africa (Maphosa and Masika 2010; Fouche et al. 2016; Sanhokwe et al. 2016).

Table 5.1 Indigenous plants known to have anthelmintic activity in South Africa

Plant species	Family	Local names	Plant part used	Method of preparation	Dosage	Reference
Aloe ferox	Asphodelaceae	Ikhala elikhulu Bitter aloe	Leaves	Infusion	The leaves are crushed, and the juice is mixed with drinking water	Maphosa and Masika (2010), Sanhokwe et al. (2016)
Elephantorrhiza elephantina	Fabaceae	Intolwane Elephant's root	Roots	Decoction	The roots are ground and boiled in water for about 30 min until the water turns red. The animal is dosed with 300 ml	Maphosa and Masika (2010), Sanhokwe et al. (2016)
Acokanthera oppositifolia	Apocynaceae	Intlungunyemba Bushman's poison	Leaves	Decoction	The leaves are ground and boiled, and the mixture is allowed to cool. The animals drenched with a dose of a 1 l bottle for adults and 300 ml bottle for kids	Hutchings et al. (1996), Van Wyk et al. (1997), Maphosa and Masika (2010), Sanhokwe et al. (2016)
Bulbine latifolia	Asphodelaceae	Ingcelwana	Leaves	Decoction	The leaves are ground and boiled. The animals are drenched with 1litre	Sanhokwe et al. (2016)
Albuca setosa	Hyacinthaceae	Ingwebeba	Tuber	Decoction	The tubers are crushed and boiled. The animals are dosed with a 500 ml bottle	Sanhokwe et al. (2016)
Centella coriacea	Apiaceae	Inyongwana	Bark	Decoction	The bark is chopped to make a decoction. After sieving the animal is dosed with approximately 500 ml	Sanhokwe et al. (2016)
Cussonia spicata	Araliaceae	Umsenge	Bark	Infusion	The bark is ground and soaked overnight, and a dose of 300 ml is given to the animal	Sanhokwe et al. (2016)
Gunnera perpensa	Gunneraceae	Iphuzi	Tuber	Decoction	The tuber is crushed and boiled, and a dose of 300 ml is administered to the animal	Sanhokwe et al. (2016)
Agapanthus praecox	Agapanthaceae	Umkondo	Leaves	Infusion	The leaves are ground and soaked in water overnight, and a dose of 500 ml is given to the animal	Sanhokwe et al. (2016)

Plants such as *Ageratum houstonianum* and *Tephrosia vogelii* have been reported to possess strong acaricidal effects (Pamo et al. 2005; Njoroge and Bussmann 2006), while *Tagetes minuta*, *Tithonia diversifolia* and *Lavandula officinalis* have tick repellent properties (Alawa et al. 2002; Njoroge and Bussmann 2006). Botanical surveys carried out in Ethiopia revealed medicinal plants traditionally used against ectoparasites of goats in ethnoveterinary practices. These plants include *Calpurnia aurea* (Aiton) Benth., *Jatropha curcas* L. (Euphorbiaceae) and *Nicotiana tabacum* L. (Solanaceae) (Bekele et al. 2012; Teklay et al. 2013; Alemu and Kemal 2015). In Zimbabwe, several plants are employed against ectoparasites such as *Aloe chabaudii*, *Lippia javanica*, *Musa paradisiaca*, *Nicotiana tabacum*, *Solanum panduriforme*, *Strychnos spinosa* and *Vernonia amygdalina* (Madzimure et al. 2011; Maroyi 2012). Table 5.3 shows some of the plants with demonstrated acaricidal activity in South Africa.

The widespread use of plant-derived ethnoveterinary medicines has led to research that resulted in the isolation of compounds (from these plants) with demonstrable anthelmintic activity: famous examples include santonic acid from *Artemisia maritima* and filicic acid from *Dryopteris filix-mas* (Setzer and Vogler 2006). Tea tree oil is also a commercially available plant-based compound with acaricidal effect against mites (Walton et al. 2000). Due to the multiplicity of plants used in ethnoveterinary medicine in developing countries, there is a need to fully characterize these in order to develop a database of plants and plant-derived compounds with anthelmintic activity for possible commercial exploitation in goat (livestock) production (Table 5.2).

5.6 Preparation of Plant-Derived Ethnoveterinary Medicines and Administration

Water, which is viewed as a universal solvent, is largely used in the preparation of plant-derived ethnoveterinary medicines by farmers (Belmain et al. 2012). Unlike farmers that make use of water, scientists generally use organic solvents to optimize the extraction of health beneficial phytochemicals from plant materials (Grzywacz et al. 2013). Commonly used organic solvents include ethanol, methanol, acetone and hexane (Paulsamy and Jeeshna 2011; Tiwari et al. 2011). Different solvents extract different active compounds due to differences in their solubility (Tiwari et al. 2011; Intisar et al. 2015).

Plant leaves and stem bark (aerial parts) are mostly used in the preparation of the plant-derived ethnoveterinary remedies (Benítez et al. 2012). Of the many plant parts used by farmers, leaves stand out as the most commonly used (Fig. 5.1). Although also found in the stem and root bark, health-giving phytochemicals are found in large concentration in the aerial parts (leaves, flowers, fruits or seeds) of plants (Geetha and Geetha 2014; Sanhokwe et al. 2016). The use of leaves is

Table 5.2 Indigenous plants known to have acaricidal activity in South Africa

Plant species	Family	Local names	Plant part used	Method of preparation	Dosage	Reference
Elephantorrhiza elephantina	Fabaceae	Intolwane	Roots	Decoction	The roots are ground and boiled in water for 30 min until the water turns red. The animals are sprayed with the decoction	Sanhokwe et al. (2016)
Aloe ferox	Asphodelaceae	Ikhala elikhulu	Leaves	Infusion	Leaves are crushed, and the juice is poured on to the skin	Sanhokwe et al. (2016)
Acokanthera oppositifolia	Apocynaceae	Intlungunyemba	Leaves	Decoction	The leaves are ground and boiled. The mixture is allowed to cool before applying to the skin	Sanhokwe et al. (2016)
Bulbine latifolia	Asphodelaceae	Ingcelwana	Leaves	Decoction	The leaves are ground and boiled. After the mixture is allowed to cool, it is applied to the skin	Sanhokwe et al. (2016)

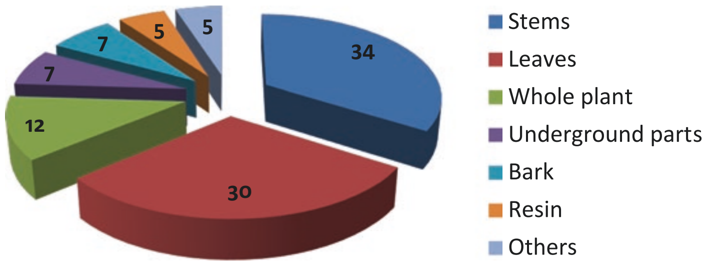

Fig. 5.1 Parts of plants used in the preparation of ethnoveterinary medicaments. (Adapted from Benítez et al. 2012)

considered sustainable (Belmain et al. 2012) since their harvest does not necessarily lead to the death of plants compared to the use of the stem or root bark.

Various processes are utilized in the preparation of plant-derived medicaments resulting in medicines being made in the form of extracts, mixtures, decoctions, infusions and macerations. Decoctions are prepared by adding cold water to the target plant material followed by boiling and simmering for 5–10 min and then straining to remove plant residues. For infusions, boiling water is added to the plant material(s), then allowing the mixture to simmer for 5–10 min before straining. Macerations are prepared by steeping the plant material(s) in cold water for up to 8 h prior to straining (Varma 2016). Some of these ethnoveterinary medicaments are prepared from mixtures of two or more plants and are deemed to act either additively and/or synergistically. All plant-derived ethnoveterinary medicinal preparations used to control internal parasites are administered through oral gavage, while the medicaments used to control external parasites are administered topically.

5.7 Anthelmintic and Acaricidal Efficacy of Plants Indigenous to South Africa

South Africa is home to a diversity of plants with some health beneficial activities. Research has been and continues to be undertaken to determine the efficacy of plant-derived ethnomedicines regarding their potential to control helminths and ectoparasites (Tables 5.3 and 5.4). As a result, characterization of medicinal plants has led to the isolation of compounds with anthelmintic activities. Waller et al. (2001) isolated lactones, like santonin from *Artemisia maritima*, which is effective against *Ascaris* species. Maphosa and Masika (2010) also noted the purgative effects of *Elephantorrhiza elephantina*, which resulted in an improved gastric and intestinal cleaning which is important in the treatment of worm infestations (Maphosa and Masika 2010).

Table 5.3 Indigenous plants screened for anthelmintic potential in South Africa

Plant species	Family	Plant part used	Assay method	Test organism	Concentration/ dose	Findings	Reference
Artemisia afra	Asteraceae	Leaves	Developmental and behavioural assay – in vitro	*Caenorhabditis elegans*	1 and 2 mg/ml	Water extract of *A. afra* had anthelmintic activity against *C. elegans*	McGaw et al. (2000)
Aloe ferox	Asphodelaceae	Leaves	Egg hatching and larval development assay	*Haemonchus contortus*	20, 10, 5, 2.5, 1.25 and 0.625 mg/ml	*A. ferox* extracts inhibited (100%) egg hatching and larval development at concentrations of 20 mg/ml	Maphosa et al. (2010a)
Leonotis leonurus	Lamiaceae	Leaves	Egg hatching and larval development assay	*Haemonchus contortus*	20, 10, 5, 2.5, 1.25 and 0.625 mg/ml	*L. leonurus* extracts inhibited (100%) egg hatching and larval development at 1.25 mg/ml	Maphosa et al. (2010a)
Elephantorrhiza elephantina	Fabaceae	Roots	Egg hatching and larval development assay	*Haemonchus contortus*	20, 10, 5, 2.5, 1.25 and 0.625 mg/ml	*E. elephantina* had 100% egg hatch inhibition at concentrations of 2.5 and 1.25 mg/ml	Maphosa et al. (2010a)
Elephantorrhiza elephantina	Fabaceae	Roots	Faecal egg count	Gastrointestinal nematodes in goats	250 and 500 mg/kg	*E. elephantina* caused a reduction ($P < 0.05$) of *Trichuris* spp. eggs on days 3 and 6 of treatment, at a dose of 250 mg/kg	Maphosa and Masika (2012)
Aloe ferox	Asphodelaceae	Leaves	Faecal egg count	Gastrointestinal nematodes in goats	250 mg/kg 500 mg/kg	A reduction ($P < 0.05$) in strongyle egg count was caused by *A. ferox* extract 500 mg/kg on days 3, 6 and 9 of treatment	Maphosa and Masika (2012)
Leonotis leonurus	Lamiaceae	Leaves	Faecal egg count	*Trichuris* spp. and coccidia oocysts	250 mg/kg 500 mg/kg	A reduction ($P < 0.05$) of faecal egg count of *Trichuris* spp. and *Eimeria* spp. oocysts were observed at 250 mg/kg dose day 9 of treatment	Maphosa and Masika (2012)

Table 5.4 Indigenous plants screened for acaricidal potential in South Africa

Plant species	Family	Plant part used	Assay method	Test organism	Findings	References
Lavandula angustifolia Mill.	Lamiaceae	Aerial parts	Tick climbing repellency	*Hyalomma marginatum rufipes*	200 mg/ml (aqueous) caused 100% repellency up to 2 h post treatment	Mkolo and Magano (2007)
Lippia javanica (Burn. F.) Spreng	Verbenaceae	Aerial parts	Tick climbing repellency	*Hyalomma marginatum rufipes*	107 mg/ml (essential oil) resulted in a repellency index of 100% at 1 h 30 min post treatment	Magano et al. (2011)
Tagetes minuta L.	Asteraceae	Aerial parts	Tick climbing repellency	*Hyalomma rufipes*	Essential oil of *T. minuta* showed a significant dose-dependent effect resulting in delayed moulting in 60% of nymphs after 25 days	Nichu et al. (2012)
Ptaeroxylon obliquum (Thunb.) Radlk	Ptaeroxylaceae	Bark	Adult immersion test	*Rhipicephalus sanguineus*	400 mg/ml (aqueous) repelled ticks for 40 min post treatment	Moyo and Masika (2013)

Nearly all of the preliminary research on the interrogation of anthelmintic activity from plant-derived preparations employ in vitro techniques in bioassaying for activity against helminths (Aremu et al. 2012). In vitro approaches, over and above being cheaper when compared to in vivo approaches, are a necessary tool in the preliminary screening process. They are essential for authentication of potential activity and can be used to determine the mechanism of action.

Having this large pool of plants indigenous to South Africa with purported anthelmintic and acaricidal potential and those that have been screened in vitro and in vivo calls for more focused studies that will help identify phytochemicals responsible for the purported and/or observed activity. Importantly, there is need to also determine the safety of these plant-derived medicaments in the animals in order to avoid a situation whereby the helminthic or ectoparasitic problem is solved at a cost to the health of the animal (Table 5.4).

5.8 Phytochemical Composition and Their Health Beneficial Activities

The health beneficial properties of medicinal plants are attributed to naturally occurring phytochemicals within the plants. Organic compounds inclusive of polyphenols, tannins, terpenes, triterpenoids, flavonoids, saponins and many others constitute phytochemicals. These phytochemicals are produced by plants largely as a mechanism against herbivory and possess biological activity that elicit physiological activities when administered to animals (Bernhoft 2010; Muthee et al. 2016). Importantly, these phytochemicals elicit many health beneficial activities such as antibacterial, antifungal, antiprotozoal and antioxidant among others (Fig. 5.2). Nkohla et al. (2015) contend that these phytochemicals, besides having prophylactic activity against parasites, are effective in the treatment of diseases.

Alkaloids, flavonoids, phenols, saponins and condensed tannins are major phytochemicals with anthelmintic activity (Van Wyk et al. 1997; Naidoo et al. 2005; Ahmed et al. 2013). Satou et al. (2002) reported that alkaloids are effective against *Strongyloides* spp., namely, *S. ratti* and *S. venezuelensis*. Alkaloids act on the central nervous system thus causing worm paralysis. Alkaloids also act as antioxidants

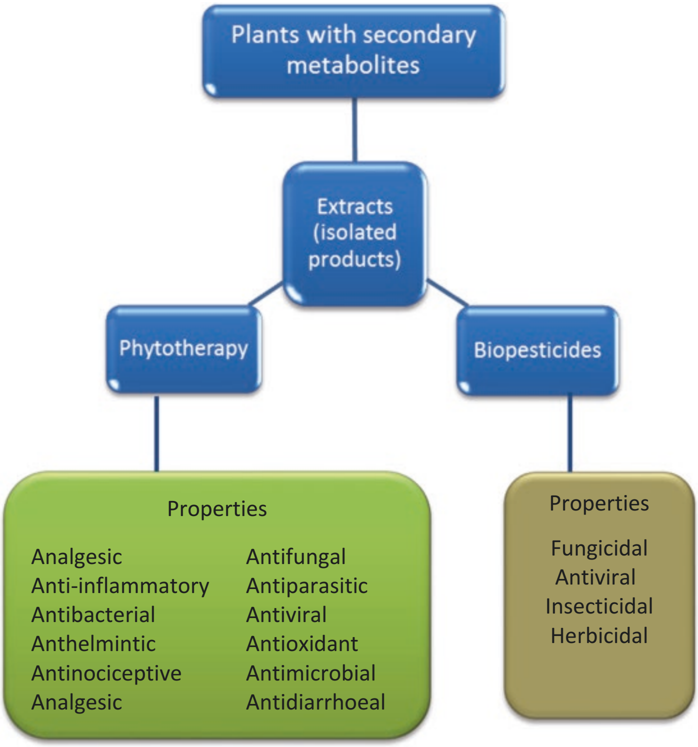

Fig. 5.2 Biological properties of phytochemicals. (Adapted from Van Wyk and Wink 2004)

by reducing nitrate generation which may impede the local homeostasis which is important for the development of parasites (Roy et al. 2010). Phenols affect the energy generation mechanism by uncoupling the oxidative phosphorylation and also impede the glycoprotein of the cell surface of the parasites thereby causing death (John et al. 2009). Saponins are reported to disrupt the cell membrane of the parasites, thereby changing the morphology of the cells in the cuticle (Geidam et al. 2007; Hrckova and Velebny 2013). Vacuolization and disintegration of tegumes consequently affect feed intake and nourishment of the parasites, resulting in parasites dying (Melzig et al. 2001; Hernandez et al. 2014).

Tannins restrict the energy generation of worms by uncoupling oxidative phosphorylation or by binding to the free protein of the gastrointestinal tract of the host or glycoprotein on the cuticles of the worms, leading to death (Patel et al. 2010; Roy et al. 2010).

Terpenes, stilbenes, coumarins, acids, alcohols, sulphurated compounds and aldehydes have been reported to have acaricidal properties (Pamo et al. 2005; Cetin et al. 2010). Terpenes are known to produce a smell that has defence mechanisms against parasites (Tawatsin et al. 2001; Dudareva et al. 2004). Flavonoids and phenols interfere with the reproduction of external parasites by inhibiting the development and maturation of oocytes (Ghosh et al. 2013). Catechin, rutin, myricitrin and quartterin are effective against external parasites through their antifeedant property (Osman et al. 2014).

5.9 Toxicity Effects of Medicinal Plants

While it is the general view that plant-derived ethnomedicines and ethnoveterinary medicines are less toxic compared to conventional pharmacological agents, it is important to interrogate and establish potential toxicity of such medicaments (Aremu et al. 2012). The fact that phytochemicals have specific biological activities warrants the need to determine accurately safe doses of ethnoveterinary medicines. The potential toxic effects of plant-derived ethnomedicines are ascribed to the same phytochemicals accountable for the anthelmintic activity (Athanasiadou et al. 2007). The excessive oral intake of alkaloids, terpenes, saponins, lactones, glycosides and phenols has been observed to cause negative effects (Athanasiadou et al. 2007).

It has also been reported that the excessive consumption of tannins has negative effects such as reduced intake and digestibility of feed, impaired rumen metabolism and mucosal toxicity (Wright 2015). Saponins are known to haemolyse erythrocytes (Athanasiadou et al. 2001). Ingestion of a saponin-rich plant is known to cause a reduction in feed intake that manifests in a host of nutritional deficiencies. Cyanogenic glycosides, terpenes or alkaloids when consumed may elicit neurological damage (Bolarinwa et al. 2016), while cysteine proteinases are very harmful in spite of their efficacy against helminths (De Amorin et al. 1999; Stepek et al. 2005). The effectiveness, mechanism of action, possible environmental pollution and also toxicity of plant-derived ethnomedicines and ethnoveterinary medicines need to be clearly established (Aremu et al. 2012). There is a misplaced view that due to their being obtained from plants (which are natural and adapted to local environs), ethnomedicines and ethnoveterinary medicaments are safe to humans and livestock, respectively (Verschaeve and Van Staden 2008). Prior to use and promotion of such plant-derived medicines, it is critical to undertake full toxicity studies in order to establish safety and potential toxic dosages (Aremu et al. 2012).

The safety assessment of the aqueous extract of *E. elephantina* was tested in rats. The safety assessment showed low toxicity on blood parameters (Maphosa et al. 2010b). Histopathological changes included pulmonary granulomas of the liver and renal crystals and pyelonephritis in the kidney. A high dose of 1600 mg/kg bwt of *E. elephantina* was not toxic, but it decreased the respiration rate in rats (Maphosa et al. 2010b). Sub-acute toxicity was observed at higher doses of 400 and 800 mg/kg bwt of *E. elephantina* through increased white blood cells, lymphocytes and serum levels of creatinine (Maphosa et al. 2010b). Chronic toxicity results showed that a dose of 400 mg/kg bwt of *E. elephantina* increased lymphocytes and platelets (Maphosa et al. 2010b). Thus, *E. elephantina* is to some extent safe because it is traditionally used at dosages lower than the doses used in the toxicity evaluation.

The toxicity evaluation of aqueous extract from *L. leonurus* caused death in rats receiving a dose of 3200 mg/kg (Maphosa et al. 2008). The extract also caused alterations in red blood cells; packed cell volume, haemoglobin concentration, mean corpuscular volume, platelets, white blood cells and its differentials at doses of 1600 mg/kg in sub-acute toxicity and 200 mg/kg in chronic toxicity (Maphosa et al. 2008). The chronic toxicity of the extract decreased the levels of urea and creatinine at 1600 mg/kg dose and reduced urea, total bilirubin, total protein, albumin, globulin, glutamine transference gamma-glutamyl transferase (GGT) and alanine transaminase at 400 mg/kg dose (Maphosa et al. 2008; Maphosa and Masika 2012). Due to the toxicity of *L. leonurus*, careful considerations should be made when using the plant for the control of helminths.

The aqueous extract from *Rhus lancea* showed toxic effects against brine shrimps (LC_{50} = 0.6 mg/ml) (McGaw et al. 2007). Thus further in vivo tests are necessary to validate the potential toxicity.

5.10 Mechanism of Action of Plants Used to Control Parasites in Goats

Although some plant preparations have anthelmintic activity in most cases, the mechanisms of action are still to be established. Phytochemicals separately or in synergy may inhibit tubulin polymerization and block glucose uptake of parasites (Jain et al. 2011). The inhibition of tubulin polymerization affects feed intake and nourishment of the parasites which leads to death of parasites. Impairment of the mucopolysaccharide membrane of worms leads to the damage of the external layer of the worm which results in a limitation of motility. The limitation in motility is known to cause paralysis and eventual death of the parasite (Chandrashekhar et al. 2008; Jain et al. 2013). The efficacy of tannins against helminths is due to their protein-binding activity (Chandrashekhar et al. 2008; Mulla et al. 2010; Tiwari et al. 2011). By binding proteins, tannins deprive the worms of dietary protein triggering malnourishment which ultimately leads to helminth death (Chandrashekhar et al. 2008; Mulla et al. 2010; Tiwari et al. 2011). Alkaloids affect the central nervous system resulting in worm paralysis (Roy et al. 2010). This effect is thought to be caused by steroidal alkaloids and oligoglycosides, which inhibit the exchange of sucrose in the gastrointestinal tract. Alkaloids also have an antioxidant effect, which may interfere with homeostasis which is essential for the development of the worm (Vadivel and Panwal 2016). In the schematic flow chart below (Fig. 5.3), some of

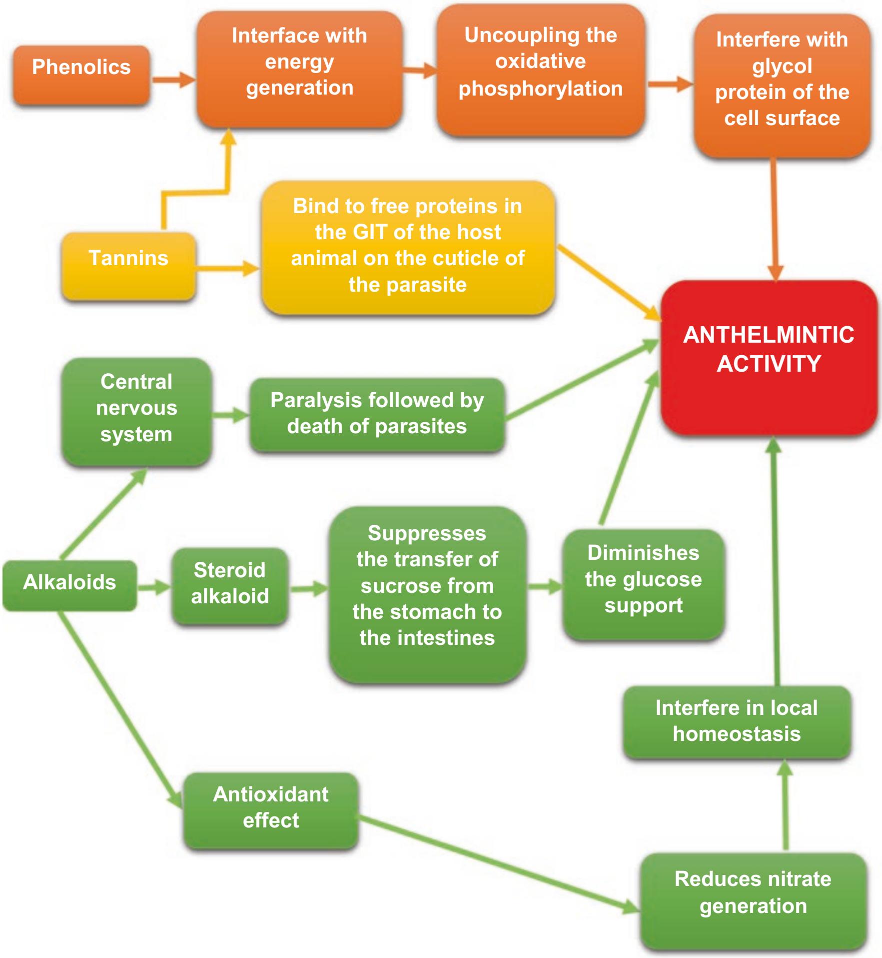

Fig. 5.3 Possible mode of action of phytochemicals as anthelminthics. (Adapted from John et al. 2009; Patel et al. 2010; Roy et al. 2010)

the mechanisms of phytochemicals against helminths are shown (John et al. 2009; Patel et al. 2010; Roy et al. 2010).

The acaricidal role of plants used to control external parasites is not well understood. However, some plant extracts are thought to have toxic effects against parasites causing reduced parasite feeding, moulting, fecundity and viability of eggs (Habeeb 2010), while others have repellent effects (Dautel 2004).

5.11 Challenges in the Use of Plant-Derived Ethnomedicines

The challenges associated with the use of plant-derived ethnoveterinary medicines include incorrect disease diagnosis, ineffective medicinal doses and unhygienic standards of preparation of the medicaments, possible toxicity and lack of transparency regarding the practice of ethnoveterinary medicine (Toyang et al. 2007; Thillaivanan and Samraj 2014). Importantly, the use of ethnoveterinary medicines is limited by geographical area (local application) characterized by poor distribution of information concerning these remedies (Andrews and Blowey 2008). From an environmental and sustainability perspective, most of the ethnoveterinary medicines are derived from indigenous plants in the range (Fig. 5.4), and their use poses a real risk of vegetation and habitat destruction (Yirga et al. 2012). The issues surrounding seasonality, determination of effective doses and treatment schedules are key questions with regard to the use of plant-derived ethnoveterinary medicines (Haverkort et al. 1996; Mosihuzzaman and Choudhary 2008; Obomsawin 2008).

The information on the utilization of medicinal plants is transmitted orally between generations; thus, there is no proper documentation regarding the doses and treatment regimens of the medicaments (Masika and Afolayan 2003; Gurib-Fakim 2006). Importantly, the use of oral narrations to pass information in the twenty-first century results in important information regarding the use of ethnoveterinary medicines being lost because there is no data retrieval system associated with the oral passage of information.

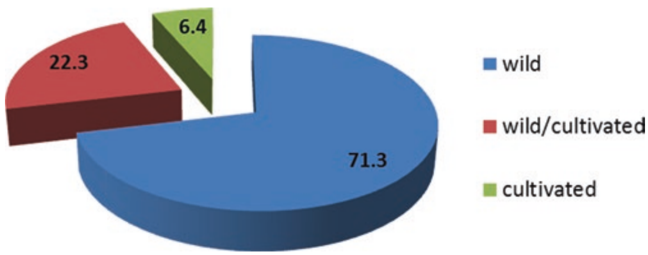

Fig. 5.4 Sources of medicinal plants used in the treatment of livestock diseases. (Adapted from Yirga et al. 2012)

5.12 Future Potential of Plant-Derived Ethnomedicines

Owing to the apparent effectiveness of plant-derived ethnoveterinary remedies in controlling parasites (external and internal), the control of parasites is gaining popularity in sheep (Ahmed et al. 2014; Gemeda et al. 2014; van Zyl et al. 2017), cattle (Moyo and Masika 2009; Min et al. 2015; Nyahangare et al. 2015), poultry (Mwale and Masika 2015; Nghonjuyi et al. 2015), pigs (Lans et al. 2007; Levecke et al. 2014) and goats (Muthee et al. 2011; Burke et al. 2012; Koné et al. 2012; Sanhokwe et al. 2016; Khada et al. 2018). However, there is a paucity of information on the potential effects of these plant-derived ethnoveterinary medicines on the gastrointestinal integrity and immunity of the livestock as well as on product (meat or milk) quality. Studies on the verification of the efficacy and potential toxicity of these plant-derived ethnoveterinary medicines are a necessity for authentication and safety.

5.13 Conclusion

While there is tremendous potential to interrogate and develop viable plant-derived ethnoveterinary medicaments for parasite (external and internal) control in goats and other livestock, there is a need for research to engage and verify claims regarding these potential medicines. Research should focus on determining efficacy, safety and identification of active phytochemicals and establishment of mechanisms of action.

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Chapter 6
Ethnoveterinary Practices for Control of Ticks in Africa

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Keywords Tick control · Ethnoveterinary plants · Ethnoveterinary practices · Cultivation of ethnoveterinary plants · Tick and tick-borne diseases · Livestock farmers in Africa

6.1 Introduction

In Africa, livestock farming is mostly small-scale and is generally confined to rural communities, where livestock farmers use open communal grazing fields, which are often infested by ticks, thus exposing their animals to tick infestations (Fig. 6.1). Tick infestations of livestock cause heavy losses to African farmers and are a major threat to their livelihoods. Most of these farmers are resource-poor and cannot afford expensive synthetic acaricides. They rely on traditional practices for mitigation of tick infestations.

Ethnoveterinary practices are widespread across Africa, especially in rural communities where traditional medicine is engrained, and traditional knowledge and

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Fig. 6.1 Tick infestation on a cattle

practices are transferred from generation to generation. Although these practices mostly rely on the use of plant-based materials, whereby whole medicinal plants or plant parts are harvested and used for treatment of parasites and microbial diseases of livestock, non-plant-based practices are many and varied across the African continent, and these include handpicking, use of fire to burn bushes, use of ash and urine, smearing of mud and clay, and rotation of grazing sites (Byaruhanga et al. 2015). Ethnoveterinary practices are, therefore, cheap because they rely on the use of easily and locally available resources. Consequently, ethnoveterinary knowledge has huge benefit potential if properly harnessed. It could lead to profitable and sustainable management of livestock in resource-poor countries.

Ethnoveterinary plants, however, are more abundant in less urbanized areas. They are easily accessible to rural communities, who depend on them for the treatment of livestock diseases. Hence, in rural areas, ethnoveterinary medicines serve as a suitable alternative to conventional veterinary medicines because the latter are not readily available in rural communities and are generally more expensive than the former. Although many studies have reported on the ethnoveterinary plants that are used for management of tick infestations on livestock in different parts of Africa, most of these have focused on specific locations, which makes it difficult to have a bird's eye view of the anti-tick ethnoveterinary practices in Africa. Therefore, the objective of this review is to collate information on the anti-tick ethnoveterinary practices in different parts of Africa for a holistic appreciation of the anti-tick plants and non-plant materials which are used in Africa. Specifically, anti-tick ethnoveterinary plants in southern, East, West, Central, and North Africa are reviewed. This chapter will facilitate identification of synergies, divergences, and comparative analysis at a continental-wide level.

6.2 Source of Information

The information of ethnoveterinary plants and practices were sourced from secondary data by searching in well-known databases such as Science Direct, Google Scholar, Researchgate, Medline, CAB Abstracts and Global Health, Pubmed, Web of Science All Databases, etc. using the following key phrases: ethnoveterinary plants in Africa, acaricidal plants, traditional practices, and ethnoveterinary practices.

6.3 Southern Africa

In southern Africa, livestock is considered to be one of the most important natural resources. Farm animals have commercial and cultural value. They play a key role in poverty alleviation in the region. Livestock provides food, skins, draught animal power for crop production, and other raw materials, such as fertilizer and medicine (Sauncoucy 1995; Chimonyo et al. 1999; Palmer and Ainslie 2006). Traditionally, livestock is used in rituals and ceremonies within these societies. Although cattle ranching is common in southern Africa, other systems of livestock production, such as mixed crop/livestock production, pastoral and nomadic/semi-nomadic systems, intensive dairy, poultry, and pig farming are still widely used in other parts of the continent (Hazell 2007). However, one of the most important threats to livestock production in southern Africa is tick parasitism.

Tick burden and subsequent losses associated with it are quite widespread and prevalent in southern Africa. Factors such as porous state borders, free-ranging wildlife, the use of communal lands, tick resistance to acaricides, high cost of acaricides, and lack of adequate veterinary services for the persistently high tick and tick-borne disease burden in the region may contribute to the widespread and prevalence of tick infestation (Mashebe et al. 2013). Unfortunately, small-scale and pastoral farmers, especially in communal areas are worst affected by tick infestations because they lack access to adequate veterinary services, information, and training, and may not have funds to buy commercial insecticides (Masika et al. 1997). Livestock farmers in southern Africa use ethnoveterinary plants and non-plant practices for treatment/prevention of tick infestations on livestock. These interventions are used as alternatives to commercial acaricides (Nyahangare et al. 2015).

Some progress on the documentation of anti-tick practices in southern Africa has been achieved, especially in South Africa and Zimbabwe (Tables 6.1 and 6.2). Ethnoveterinary plants used by farmers in the Eastern Cape Province, the Tsonga people, and the North West province have been documented. In Zimbabwe, ethnobotanical surveys carried out in four semi-arid districts yielded a comprehensive list of ethnoveterinary plants (51 species) that are used complementarily for control of tick infestations. Besides South Africa and Zimbabwe, information on ethnoveterinary

Table 6.1 Ethnoveterinary plants used for tick management in southern Africa

Plant species	Family	Local name (Tribe)	Parts used and preparation methods	Country	Reference	Validation reference
Bauhinia petersiana Bolle.	Fabaceae	Mutyatyambe (Shona)	Crush leaves, mix with water	Zimbabwe	Nyahangare et al. (2015)	
Monadenium lugardae N.E.Br.	Euphorbiaceae	Chisvosve (Shona)	Whole plant crush and mix with water 24 h	Zimbabwe	Nyahangare et al. (2015)	
Albizia amara (Roxb.) B. Boivin	Fabaceae	Umbola (Ndebele)	Crush leaves + water + spray	Zimbabwe	Nyahangare et al. (2015)	
Aloe excelsa A. Berger.	Aloaceae	Mhangani(Shona)	Crush leaves, mix with water for 24 h and spray	Zimbabwe	Nyahangare et al. (2015)	
Capsicum annuum L.	Solanaceae	Mhiripiri (Shona)	Crush the fruits and mix with soot in water and spray	Zimbabwe	Nyahangare et al. (2015)	
Carissa edulis (Forssk.)	Apocynaceae	Umlugulu (Ndebele)	Grind leaves, mix with water in the ratio 1:4 and spray	Zimbabwe	Nyahangare et al. (2015)	
Cucumis anguria L.	Cucurbitaceae	Mujachacha (Shona) Amagaka (Ndebele)	Collect ripe fruits (yellow), crush, and mix with water and spray	Zimbabwe	Nyahangare et al. (2015)	
Ornithogalum sp.	Asparagaceae	Chihanyanisi (Shona)	Roots are crushed and mixed with water	Zimbabwe	Nyahangare et al. (2015)	
Cissus quadrangularis L.	Vitaceae	Chiololo (Shangani), Murunjurunju (Shona)	Stems are crushed and mixed with water to spray	Zimbabwe	Nyahangare et al. (2015)	
Rotheca eriophylla	Lamiaceae	Umnukanja (Ndebele) Munukanja (Shona)	Leaf macerations are soaked in water and sprayed	Zimbabwe	Nyahangare et al. (2015)	
Combretum imberbe Wawra	Combretaceae	Muchenarota Mutsviri (Shona)	Ash of the bark and twigs are applied as dust on infestation sites	Zimbabwe	Nyahangare et al. (2015)	
Ptaeroxylon obliquum (Thunb.) Radlk.	Rutaceae	Umpandula (Ndebele)	Leaves are crushed soaked in water and used as spray	Zimbabwe	Nyahangare et al. (2015)	
Gnidia kraussiana Meisn.	Thymelaeaceae	Chitupatupa (Shona)	Whole plant is crushed soaked in water and used as spray	Zimbabwe	Nyahangare et al. (2015)	

Lippia javanica (Burm.f.) Spreng.	Verbenaceae	Zumbani (Shona) Umsuzwane (Ndebele)	Leaves are crushed soaked in water and used as spray	Zimbabwe	Nyahangare et al. (2015)	Magano et al. (2011)
Maerua edulis (Gilg&Gilg-Ben. DeWolf)	Capparidaceae	Katunguru (Shona)	Roots are mixed with water and sprayed	Zimbabwe	Nyahangare et al. (2015)	
Datura stramonium L.	Solanaceae	Iyoyi (Ndebele), Chowa (Shona)	Leaves are crushed soaked in water and sprayed on animals	Zimbabwe	Nyahangare et al. (2015)	Ghosh et al. (2015)
Vernonia colorata (Willd.) Drake.	Compositae/ Asteraceae	Munyatera (Shona)	Roots are crushed and mixed with water for an hour, and the mixture is used as spray	Zimbabwe	Nyahangare et al. (2015)	
Spirostachys africana Sond.	Euphorbiaceae	Mutovhoti (Shona)	Barks are mixed with water	Zimbabwe	Nyahangare et al. (2015)	
Strychnos spinosa Lam.	Strychnaceae	Matamba (Shona)	Unripe fruits are crushed and mixed with water, and then used as spray	Zimbabwe	Nyahangare et al. (2015)	
Tagetes minuta L.	Compositae/ Asteraceae	Munyakambanje (Shona)	Whole plant is crushed and mixed with water	Zimbabwe	Nyahangare et al. (2015)	Nchu et al. (2012)
Terminalia sericea Burch. ex DC.	Combretaceae	Mususu (Shona)	Leaves are crushed and mixed with water for spray	Zimbabwe	Nyahangare et al. (2015)	
Vigna unguiculata L.	Leguminosae—Papilionoideae	Cowpea (English)	Ash from burnt empty pods are applied on tick sites	Zimbabwe	Nyahangare et al. (2015)	
Xeroderris stuhlmannii (Taub.) Mendonca & Sousa	Papilionaceae	Murumanyama (Shona)	Crushed stems are applied directly on infestation sites	Zimbabwe	Nyahangare et al. (2015)	
Zantedeschia albomaculata (Hook.) Baill.	Araceae	Mufanawembudzi (Shona)	Stems are crushed, mixed with water and drenched	Zimbabwe	Nyahangare et al. (2015)	
Ricinus communis L.	Euphorbiaceae	Umtshafuto (Ndebele)	Grind leaves and apply paste on tick-infested sites	Zimbabwe	Nyahangare et al. (2015)	
Cissus quadrangularis L.	Vitaceae	Nyangala (Tsonga)	Crush aerial parts, mix with water and use as poultice. It is used to control maggots and ticks	South Africa	Luseba and Van Der Merwe (2006)	

(continued)

Table 6.1 (continued)

Plant species	Family	Local name (Tribe)	Parts used and preparation methods	Country	Reference	Validation reference
Carica papaya L.	Caricaceae	*Mupopo* (Shona)	Leaves are mixed with water for 12 hours to spray	Zimbabwe	Ndhlovu (2014)	
Aloe marlothii subsp. *marlothii*	Asphodelaceae	Mokgopa (Setswana)	Leaves	South Africa	van der Merwe et al. (2001); Hutchings et al. (1996), Roberts (1990)	Mawela (2008)
			Decoction—crushed leaves in boiled water		Roberts (1990)	
			Infusion or leaf sap directly squeezed out of leaves and applied immediately		In Mawela (2008) and originally obtained from ARC-OVI/EVM database	
Clerodendrum glabrum E. Mey. var. *glabrum*	Verbenaceae	Munukhatshilongwe (Venda)	Infusion—leaves are crushed and mixed with water applied per os	South Africa	Hutchings et al. (1996), Mabogo (1990)	Mawela (2008)
		Umqangazane (Zulu)	Decoction—¼ cup of leaves in 2 cups of water is boiled for 15 min, strained and applied per os		Roberts (1990)	
		Mohlokohloko (Sotho)	Decoction—leaves and twigs are boiled in water to cover it for 20 min, then strained and applied topically		Roberts (1990); Hutchings et al. (1996)	
		Tinderwood tree (Eng)			Based on ARC-OVI/EVM database	
		Kaster boon (Afr)			Matlebyane et al. (2010)	

Aloe ferox Mill.	Asphodelaceae	Mokopa (Tswana) Umhlaba (Zulu)	Infusion from the leaves and water which is left to stand overnight applied topically	South Africa	Roberts (1990)	Mawela (2008)
		Hlaba (Sotho)	Fresh leaf juice is squeezed out and applied per os		Hutchings et al. (1996), Roberts (1990)	
		Bitter/red aloe (Eng) Bitteraalwyn (Afr)	Juice is collected and concentrated by boiling and is left to crystallize. The crystals are either used or are powdered before use		Fourie et al. (2005)	
Sclerocarya birrea (A.Rich.) Hochst.	Anacardiaceae		Bark, root, and fruit	South Africa	Hutchings et al. (1996)	Fouché et al. 2017
					Van Wyk et al. (2009)	
Antizoma angustifolia (Burch.) Miers ex Harv.	Menispermaceae		Roots	South Africa	Fouché et al. (2017)	Fouché et al. (2017)
Hypoxis rigidula Baker	Hypoxidaceae	Tshuka (Tswana)	Bulb	South Africa	van der Merwe et al (2001)	Yes
						Fouché et al. (2017)
Gloriosa superba L.	Colchicaceae	isimiselo (isiZulu)	Comb	South Africa	Roberts (1990)	
Ptaeroxylon obliquum (Thunb.) Radlk	Rutaceae	umThathi (Xhosa)	Powdered bark is added to a wash to kill cattle ticks	South Africa	http://pza.sanbi.org/ptaeroxylon-obliquum	

Table 6.2 Non-plant ethnoveterinary practices in Africa

Materials	Preparation method	Indication	Country	References
Mechanical grease	It is applied topically as used paste	Dermatophilosis and tick	Zimbabwe	Ndhlovu (2014)
Used engine oil or kerosene	It is applied topically as used oil	Dermatophilosis and tick	Zimbabwe	Ndhlovu (2014)
	Smearing or rubbing used automobile oils on birds results in parasites falling off the birds	External parasites	Botswana	Moreki (2013)
			South Africa	Masika et al. (1997)
			Kenya	Hlatshwayo and Mbati (2005)
			Tanzania	Kioko et al. (2015)
Paraffin	Applied topically	Dermatophilosis and tick	Zimbabwe	Ndhlovu (2014)
	Smearing or rubbing paraffin on the birds resulted in parasites falling off the birds	External parasites	Botswana	Moreki (2013)
				Masika et al. (1997)
Soap	Applied as powder or dissolved in water	Dermatophilosis and tick	Zimbabwe	Ndhlovu (2014)
	Bathing birds in a solution of washing detergent	External parasites	Botswana	
Water	Apply warm water topically	Dermatophilosis and tick	Zimbabwe	Ndhlovu (2014)
	The use of boiling water in the shelters for chickens	External parasites	Botswana	Moreki (2013)
Ash	Apply topically in dry form	Dermatophilosis and tick	Zimbabwe	Ndhlovu (2014)
	The use of hot ash in the shelters for birds	External parasites	Botswana	Moreki (2013)
Cow dung	Topically as a paste to attachment sites in order to suffocate ticks	Dermatophilosis and tick	Zimbabwe Tanzania Kenya	Ndhlovu (2014)
Disinfectant	Mixed with water Topically	Ticks	South Africa	Hlatshwayo and Mbati (2005)
Fire/smoke	Burning of old/long grass to kill ticks	Ticks	Kenya Tanzania Southern Africa	Kioko et al. (2015)
	Cattle sheds are smoked to make ticks fall off			

practices from most of the countries (Lesotho, Mozambique, Swaziland, Botswana, and Angola) in southern Africa are scanty, warranting ethnobotanical surveys in these countries to fill the existing data gaps.

6.4 East and North Africa

The use of ethnoveterinary plants for reduction of tick burden on livestock is quite widespread in East Africa. A number of reports from the region contain inventories of ethnoveterinary plants and non-plant practices that are used for controlling ticks in Uganda, Kenya, Tanzania, and Ethiopia. Most of the ethnoveterinary information was obtained from Karamojong pastoralists, peasant livestock owners in the Wellega, Illubabor, and Keffa Provinces in western Ethiopia, the Borana people of Kenya and Ethiopia, and the Maasai pastoralists through discussions, interviews, and questionnaires. Although the anti-tick plants belong to a wide variety of plant families, the most frequently reported families from this region were Solanaceae, Euphorbiaceae, and Fabaceae (Table 6.3). On the other hand, there are fewer reports on ethnoveterinary practices in North Africa. Most of the reports of anti-tick plants in Egypt have focused on experimental validation of essential oil of anti-tick plant species, and these are listed in a review paper by Wanzala (2017). Ethnoveterinary studies in East Africa are picking up steam. Recently, Opiro et al. (2010) documented 13 plant species in eight families that are used to control ticks in the Gulu region of Uganda. In Tanzania, Kioko et al. (2015) inventoried 25 species that are used for the treatment of tick-borne diseases by Maasai cattle farmers in the Arusha region in Northern Tanzania.

6.5 West and Central Africa

In West and Central Africa, livestock is vital to subsistence and economic development of the countries. The livestock resource base consisting of cattle, sheep, goats, and camels provides a flow of essential food products throughout the year and is a major source of revenue and export earnings. It also provides employment and income to millions of people in rural areas, supporting crop production by contributing to the labor force and providing manure. The sale of livestock and their products often constitutes the only source of cash income in rural areas, and hence the only way in which subsistence farmers can buy consumer goods and procure the improved seeds, fertilizers, and pesticides needed to increase crop yields. The contribution of livestock to the national economy is quite important in these countries. However, tick infestation is one of the most important causes of huge economic loss. Ticks affect their hosts by damaging hides, reducing their growth rates and milk production, transmitting disease organisms that are often lethal, cause paralysis, and cause injuries which may lead to secondary infections. From a recent survey

Table 6.3 Ethnoveterinary plants that are used for tick management in East Africa

Plant species	Family	Local name (Tribe)	Parts used and preparation methods	Country	Reference	Validation reference
Albizia amara (Roxb) Boivin ssp. *sericocephala*	Fabaceae	Ekwakwe (Bokora)	Leaves Oil poultice	Uganda	Grade et al. (2009)	
Cyphostemma ukerewense (Gilg) Desc	Vitaceae	Amana-Akura (Pian)	Roots Powder topically	Uganda	Grade et al. (2009)	
Euphorbia bongensis Kotschy & Peur	Euphorbiaceae	Jeriman (Pian)	Whole plant Water extract	Uganda	Grade et al. (2009)	
Ipomea longituba Hallier f	Convolvulaceae	Ematwae (Bokora)	Roots Poultice	Uganda	Grade et al. (2009)	
Neorautanenia mitis (A.Rich.) Verdc.	Fabaceae	Ebuto (Bokora)	Roots Water extract	Uganda	Grade et al. (2009)	
Nicotiana tabacum L.	Solanaceae	Etaba (Pian)	Leaves Dissolve snuff in water, add urine, wash	Uganda	Grade et al. (2009)	Choudhary et al. (2004)
			Leaves Mixed with a mineral called Magadi Soda to form a product called Kupetaba	Kenya	Mwangi (1996)	
			A concoction mixture prepared with *Solanum incanum* and *N. tabacum*			
			Fresh leaves are crushed, mixed with water, and the extract is used for washing animals	Uganda	Byaruhanga et al. (2015)	
Tephrosia vogelii Hook f	Fabaceae	Fishbin (Pian)	Leaves Water extract	Uganda	Grade et al. (2009)	
Olea europaea subsp. *cuspidata*	Oleaceae		Whole plant extract is mixed with that of Cadia purpurea	Kenya	Akall (2009), Wanzala (2017)	
Margaritaria discoidea (Baill) G.L.	Phyllanthaceae		Latex	Kenya	Kaaya et al. (1995)	Kaaya et al. (1995)

Commiphora erythraea Engler	Burseraceae		Borana people in Southern Ethiopia use gum resin and camel urine are mixed to form paste	Kenya	Zorloni (2007)	Carroll et al. (1989)
			Maasai tribe uses the sap to treat ticks	Ethiopia		
			Decoction of the bark of the plant is used to treat ticks on cows			
Calpurnia aurea L.	Fabaceae		People of western Ethiopia use juice of crushed leaves and bark for tick control		Zorloni (2007)	Fouché et al. (2017)
			The Borana people of Kenya and Ethiopia use soak leaves in cold water for tick control		Regassa (2000)	Zorloni et al. (2010) Nana et al. (2016)
Azadirachta indica Adr. Juss.	Meliaceae		In southern Ethiopia, the leaves are crushed and soaked in water, and it is taken orally or applied topically against ecto-parasites	Ethiopia	Zorloni (2007)	Abdel-Shafy and Zayed (2002)
			Seed oil also offer protection against ticks	Kenya		Mansingh and Williams (2002), Ndumu et al. (1999), Solomon et al. (2000)
			Fruits are dried, crushed into powder, and then boiled to extract an oil suspension which is used	Uganda	Byaruhanga et al. (2015)	
Solanum incanum L.	Solanaceae		Fruit juice is used. The juice can be used in a concoction mixed with *N. tabacum*	Kenya	Akall (2009)	Madzimure et al. (2013)
				Ethiopia		Regassa (2000)
Dalbergia melanoxylon Guill. & Perr.	Fabaceae	Ekapangiteng (Ngakarimojong)	Crushed fresh roots and bark are mixed with water, and the liquid extract is used to drench animals	Uganda	Byaruhanga et al. (2015)	

(continued)

Table 6.3 (continued)

Plant species	Family	Local name (Tribe)	Parts used and preparation methods	Country	Reference	Validation reference
Commiphora africana (A. Rich.) Engl.	Burseraceae	Ekadeli (Ngakarimojong)	Crushed fresh roots are mixed with water, and the liquid extract is used for washing animal body	Uganda	Byaruhanga et al. (2015)	
Acacia drepanolobium Sjostedt.	Fabaceae	Eyelel (Ngakarimojong)	Crushed fresh roots are mixed with water, and the liquid extract is used for washing animal body	Uganda	Byaruhanga et al. (2015)	
Acacia gerrardii Benth.	Fabaceae	Eminit (Ngakarimojong)	Crushed fresh roots are mixed with water, and the liquid extract is used for washing animal body	Uganda	Byaruhanga et al. (2015)	
Cucumis aculeatus Cogn.	Cucurbitaceae	Eyome (Ngakarimojong)	Crushed fruits are mixed with water to form solution, which is used for washing animal body	Uganda	Byaruhanga et al. (2015)	
Adenium obesum (Forssk) Roem. & Schult	Apocynaceae	Elemu (Ngakarimojong)	A piece of fresh root tuber is crushed and mixed with water to obtain a solution which is used as an animal body wash	Uganda	Byaruhanga et al. (2015)	
Boscia angustifolia A.Rich.Var.angustifolia	Capparaceae	Senikook (Ngakarimojong)	Crushed fresh roots are mixed with water, and the liquid extract is used for washing animal body	Uganda	Byaruhanga et al. (2015)	
Tylosema fassoglensis (Schweinf) Torre.Hillc	Fabaceae	Ebuto (Ngakarimojong)	Crushed fresh roots are mixed with water, and the liquid extract is used for washing animal body	Uganda	Byaruhanga et al. (2015)	
Desmidorchis acutangula Decne.	Apocynaceae	Lolemo (Ngakarimojong)	Fresh leaves and stem crushed together and the liquid part extracted	Uganda	Byaruhanga et al. (2015)	
Lepidium sativum L.	Brassicaceae		Seeds are crushed and mixed with cattle faeces, and then smeared on cattle	Ethiopia	Regassa (2000)	Regassa (2000)
Ficus brachypoda (Miq.) Miq.	Moraceae		Latex	Ethiopia	Regassa (2000)	Regassa (2000)

Euphorbia obovalifolia A.Rich.	Euphorbiaceae		Latex	Ethiopia	Regassa (2000)	Regassa (2000)
Euphorbia candelabrum Trémaux ex Kotschy	Euphorbiaceae		Latex	Kenya	Wanzala (2017)	
Phytolacca dodecandra L'Hér.	Phytolaccaceae		Juice of crushed leaves	Ethiopia	Regassa (2000)	Regassa (2000)
Vernonia amygdalina Delile	Asteraceae		Juice of crushed leaves	Ethiopia	Regassa (2000)	Regassa (2000)
Capsicum spp.	Solanaceae		Spice of Capsicum spp. *mixed with butter*	Ethiopia	Regassa (2000)	
Commiphora tenuis Vollesen	Burseraceae		Leaf juice is rubbed on camel's coat	Kenya	Wanzala (2017)	
Pennisetum typhoides (Burm.f.) Stapf & C.E.Hubb.	Gramineae/ Poaceae		Corm and stem powder/dust	Niger	Puffet (1985), Wanzala (2017)	
Melinis minutiflora Beauv.	Poaceae	Molasses	Bruised leaves of the grass are rubbed over the coat of animals	Tanzania	Mwase et al. (1990)	Mwangi et al. (1995), Prates et al. (1998), Fernández-Ruvalcaba et al. (2004)
Aloe spp.	Xanthorrhoeaceae		Topical application of leaf paste formulated in paraffin oil and kitchen ash	Kenya	ITDG and IIRR (1996), Wanzala (2017)	
Gynandropsis gynandra (L.) Briq.	Capparidaceae	Akeyo (Luo)	Aerial parts are used as well essential oil	Kenya	Wanzala (2017)	Lwande et al. (1998)
Tephrosia vogelii Hook F.	Fabaceae/ Papilionoideae/ Leguminosae		Infusions of leaf, root, pod, seed, bark, and whole plant are used as dips	Malawi	Niang (1987), Kambewa et al. (1998), Habeeb (2010), Wanzala (2017)	Gadzirayi et al. (2009)
				Tanzania		Onyambu et al. (2014)

(continued)

Table 6.3 (continued)

Plant species	Family	Local name (Tribe)	Parts used and preparation methods	Country	Reference	Validation reference
Solanecio mannii (Hook. F) C. Jeffrey	Asteraceae	Ooko (local name in Guru and Amuru districts)	Leaves crushed, put in water and the filtrate is sprayed directly on tick-infested areas on the animal body	Uganda	Opiro et al. (2010)	
Sonchus oleraceus L.	Asteraceae	Acwaa (local name in Guru and Amuru districts)	Leaves are pounded, mixed with water and decanted, and it is applied directly on tick affected areas	Uganda	Opiro et al. (2010)	
Symphostema adedacule L.	Cucurbitaceae	Anunu (local name in Guru and Amuru districts)	Fresh plant materials (roots and vegetative parts) are crushed and mixed with water to make a concentrated solution. It is stirred and the filtered, and the filtrate is sprayed on tick affected areas	Uganda	Opiro et al. (2010)	
Pseudocedrela kotschy (Schweinf.) Harms	Meliaceae	Oput (local name in Guru and Amuru districts)	Leaves are pounded, mixed with water and decanted, and it is applied directly on tick affected areas	Uganda	Opiro et al. (2010)	
Ajuga remota Benth	Lamiacea	Ongolpil (local name in Guru and Amuru districts)	Roots and leaves are crushed mixed with water and decanted, and it is applied directly on tick affected areas	Uganda	Opiro et al. (2010)	
Plectranthus barbatus Andr.	Lamiacea	Oyee (local name in Guru and Amuru districts)	Plant leaves are pounded and mixed with little water, and it is applied directly on tick affected areas	Uganda	Opiro et al. (2010)	
Euphorbia hirta L.	Euphorbiaceae	Acak (local name in Guru and Amuru districts)	Sap is extracted directly from fresh plant, and smeared on affected areas	Uganda	Opiro et al. (2010)	
Cassia didymobotrya Fresen.	Leguminosae/ Fabaceae	Lurogo (local name in Guru and Amuru districts)	Fresh leaves are crushed, mixed with water and sprayed directly on tick affected areas	Uganda	Opiro et al. (2010)	

Phaseolus lunatus L.	Leguminosae/ Fabaceae	Muranga (local name in Guru and Amuru districts)	Dried bean plants are burnt, ashes mixed with water and the filtrate is applied directly on tick affected areas	Uganda	Opiro et al. (2010)	
Erythrina abbyssinica Lam. ex DC	Leguminosae/ Fabaceae	Lucooro (local name in Guru and Amuru districts)	Fresh roots and stem bark is pounded and the fine particles are mixed in water to form a concentrated solution that is filtered and sprayed on tick affected areas	Uganda	Opiro et al. (2010)	
Cucurbita maxima Duchesne	Cucurbitaceae	Abanceng (local name in Guru and Amuru districts)	Fresh leaves are pounded, mixed with water and decanted, and sprayed directly on tick affected areas	Uganda	Opiro et al. (2010)	
Kigelia africana (Lam.) Benth	Bignoniaceae	Yago (local name in Guru and Amuru districts)	Fresh fruit/bark is pounded until fine and mixed with water, stirred and filtered. The filtrate is sprayed on affected areas using a pump	Uganda	Opiro et al. (2010)	

carried out by Awa et al. (2015) in Cameroon, *Rhipicephalus (Boophilus) decoloratus* was the most abundant species with a relative prevalence of 62.2%, followed by *Amblyomma variegatum* (28.4%), other *Rhipicephalus* spp. (8.4%), and *Hyalomma* spp. (0.3%). These species are known to transmit diseases, such as anaplasmosis, babesiosis, and ehrlichiosis, which can be lethal to the animals. They are also responsible for reduction in the production of meat and milk, and mortality in livestock in sub-Saharan African countries.

In the absence of effective vaccines against ticks and tick-borne diseases, control of the vector remains the best option. In most production systems, control of ticks is usually achieved with the use of synthetic chemical acaricides, such as organophosphates, pyrethroids, and amidine compounds despite their well-known ecological disadvantages including development of resistance to acaricides. However, more effective and sustainable integrated control methods need to be developed. It is, therefore, essential to consider the possibilities for using indigenous African plants as sources of acaricides. Most of the documented ethnoveterinary plant species of these regions are spread across ten plant families (Table 6.4). Many of these species are used for tick control in other parts of the continent. However, compared to East and southern Africa, the number of records of ethnoveterinary plants is fewer, indicating possible under-reporting of ethnoveterinary plants in West and Central Africa; these two regions are home to many communities of resource-poor pastoralists, which generally tend to rely on ethnoveterinary practices for treatment of livestock diseases. Interestingly, these knowledge gaps present opportunities for researchers to carry out ethnoveterinary surveys.

6.6 Evaluation and Validation of Medicinal Plants

Indigenous knowledge is held by knowledge specialists, who fall into two categories: pragmatic and esoteric specialists (Ndenecho 2011). Indigenous knowledge systems are not static but are continuously involving and incorporating new ideas. Scientific evaluation and validation of medicinal plants and knowledge systems can lead to refinement and exchange of knowledge between modern and traditional systems. However, for scientific evaluation and validation to be effective, efficient, and reliable, testing protocols for efficacy should be developed that will reflect the expected performance of plant material under natural field conditions. Ethnoveterinary leads have proven to be very valuable in identifying bioactive plants. Furthermore, they complement other methods of selecting plants for bioactivity testing such as random selection and chemotaxonomic approaches (Katerere and Luseba 2010). Discrepancies between experimental results and ethnoveterinary claims can damage the relationship between modern and traditional knowledge specialists, and potentially impede transfer of knowledge. To mitigate conflicts and mistrust, it is, therefore, important to employ standardized, low-cost, and experimental and non-experimental methods for effective documentation and evaluation of potential efficacy of ethnoveterinary remedies. In ethnoveterinary medicine, most of the treatments are solutions prepared by boiling or macerating

Table 6.4 Ethnoveterinary plants that are used for tick management in Central and West Africa

Plant species	Family	Common English name (Tribe)	Parts used and preparation methods	Country	Reference
Ageratum houstonianum Mill.	Asteraceae	Blue Mink	Essential oils from flowers and leaves are toxic to *Rhipicephalus lunulatus* and *Rhipicephalus appendiculatus*	Cameroon	Pamo et al. (2002, 2004a)
Azadirachta indica Adr. Juss.	Meliaceae	Neem tree	Fruit oil extracts caused mortality of *Amblyomma variegatum* larvae	Nigeria, Cameroon	Ndumu et al. (1999)
Melinis minutiflora Beauv.	Poaceae	The grass family	Whole plant extract is toxic/ repellent to ticks	Cameroon, Chad, Central African Republic	Thomson et al. (1978)
Tephrosia vogelii Hook F.	Fabaceae	Fish-poison-beans	Leaf, root, pod, seed, bark, and whole plant. Rotenoids present in the infusion acts like modern dips toxic to 1, 2, and 3 host ticks	Cameroon	Habeeb (2010)
Chromolaena odorata (L.) King and Robins (Fig. 6.2)	Asteraceae	Communist pacha	Toxic effects of essential oil from leaves to *Rhipiciphalus lunulatus* Neumann	Cameroon	Pamo et al. (2004a, b)
Eucalyptus saligna Smith	Myrtaceae	blue gum	Toxic effects of essential oil from leaves to *Rhipiciphalus lunul*atus Neumann	Cameroon	Pamo et al. (2004b)
Ocimum gratissimum L.	Lamiaceae	Clove basil	Toxic effects of essential oil from leaves to *Rhipiciphalus (Boophilus) microplus* larvae	Cameroon	Hue et al. (2015)

(continued)

Table 6.4 (continued)

Plant species	Family	Common English name (Tribe)	Parts used and preparation methods	Country	Reference
Ocimum urticaefollium Roth	Lamiaceae	African basil	Toxic effects of essential oil from leaves to *Rhipiciphalus (Boophilus) microplus* larvae	Cameroon	Hue et al. (2015)
Euphorbia kamerunica Pax	Euphorbiaceae	Kerenahi	–	Cameroon	Ndenecho (2011)
Psorospermum guineense (L.) Hochr.	Clusiaceae	Sowoiki	–	Cameroon	Ndenecho (2011)
Solanum aculeastrum Dunal	Solanaceae	Gitte Naii	–	Cameroon	Ndenecho (2011)
Khaya anthotheca (Welw.) C.DC.	Meliaceae	Kahi	–	Cameroon	Ndenecho (2011)
Pennisetum typhoides (Burm.f.) Stapf & C.E.Hubb.	Gramineae/Poaceae		Corm and stem powder/dust	Niger	Puffet (1985), Wanzala (2017)

Fig. 6.2 *Chromolaena odorata*

Fig. 6.3 *Ageratum houstonianum*

plant parts in water and then administering the solution to the animal orally and topically. The use of other solvents such as acetone, ethanol, and dichloromethane as extractants instead of water may affect reliability of experimental tests as validation tools (Fig. 6.3).

6.7 Cultivation and Commercialization of Ethnoveterinary Plants

Ethnoveterinary plants are used in traditional practices in many developing countries, and their use has been increasing steadily. The demand for medicinal plants will continue to grow, and 2002, it was estimated that the trade of medicinal plants in South Africa was worth R270 million annually (Dold and Cocks 2002). In Zimbabwe, while ethnoveterinary plants are used to complement conventional veterinary medicine, herbal medicine is still considered as the most affordable and easily accessible form of treatment in primary healthcare (Maroyi 2013). In South Africa ten medicinal species: *Agathosma betulina* (Rutaceae), *Aloe ferox* (Asphodelaceae), *Aspalathus linearis* (Fabaceae), *Harpagophytum procumbens* (Pedaliaceae), *Hypoxis hemerocallidea* (Hypoxidaceae), *Merwilla natalensis* (Hyacinthaceae), *Pelargonium sidoides* (Geraniaceae), *Siphonochilus aethiopicus* (Zingiberaceae), and *Sutherlandia frutescens* (Fabaceae) are commercially cultivated. The increasing demand for medicinal plants and the excess strain placed on the survival of wild plants necessitates the development of efficient and sustainable commercial cultivation of ethnoveterinary plants; it should be one of the focal areas for research. Technologies such as hydroponics, aquaponics, and tissue culture, as well as plant breeding, are increasingly being utilized in crop cultivation are potential areas for research. Sound knowledge of plant responses to abiotic and biotic factors could be exploited for optimal crop and secondary metabolite production by manipulating these factors during cultivation. Farming of medicinal plants could improve household earnings, create jobs, and reduce over-exploitation and harvesting of some wild and endangered species. However, this would have to be done in a sustainable manner and within the context of protecting and strengthening the cultural values of biodiversity and creating a positive attitude toward biodiversity conservation in general.

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Part II
Sociological Aspects and Considerations Relating to Documentation of Ethnoveterinary Medicine

Chapter 7
Gender Aspects and Multiple Contexts in Ethnoveterinary Practice and Science

Tedje van Asseldonk and Cheryl Lans

Keywords Feminist animal studies · Gender bias · Systems theory · IEZ · Non-experimental validation · Zoopharmacognosy · Biopiracy · Ethics · Context of practice and research · Methodology

7.1 Introduction

The Institute for Ethnobotany and Zoopharmacognosy (IEZ) in the Netherlands was founded in 1996. The IEZ conducts academic research on ethnoveterinary medicine, zoopharmacognosy, and ethnobotany and also teaches and consults on these subjects (including herbs for animals). The IEZ ran the Netherlands Association for Phytotherapy (NVF) from 1999 to the end of 2016. The IEZ initiated and co-ordinated two NVF-IPC projects (government-funded cooperative innovation projects) involving 13 + 18 (in total 31) companies working in the field of natural products for animal health and human healthcare. The IEZ has also worked with young people doing wild harvesting in the Netherlands, farmers selling wild edible plants (WEPs), restaurants serving WEPs and Slow Food Netherlands. On all topics, the IEZ collaborates with the professional agricultural universities of Dronten/Almere and den Bosch. There is regularly cooperation with the Louis Bolk Institute (LBI), a private research institute for organic agriculture, and with RIKILT (Wageningen University & Research (WUR), Institute for Food Safety) mainly on ethnoveterinary topics and sometimes on zoopharmacognosy topics.

The IEZ uses both experimental and non-experimental validation of herbal remedies. In our vision, the context of a researcher and the context of the practice that is being researched, the methodology used and ethical backgrounds are very much intertwined. There may be gender aspects involved that need more consideration.

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We will show some examples of this. Since both authors have been involved in the field of ethnoveterinary medicine (EVM) for about 20 years, we have noticed a change in methodology and focus that we would like to discuss in this chapter.

7.2 Rise and Embedding of Ethnoveterinary Medicine as a Science

A short definition for Ethnoveterinary Medicine (EVM) would be Traditional Animal Health Care (Lans et al. 2006). EVM was originally thought of as veterinary anthropology and EVM data often consisted of anecdotal evidence, testimonials, and case studies (of methods, skills, knowledge, beliefs, and animal health practices) collected in the field (McCorkle et al. 1996). Colonial-era scientists knew of EVM, but ignored it and implemented their own Western-technology projects. Drs Constance McCorkle, Evelyn Mathias, Paul Mundy, and others started working with EVM in development projects in Africa. The 1970s saw the emergence of publications on indigenous knowledge and interest from the Food and Agriculture Organization (FAO). The first two indigenous knowledge centers were the Center for Indigenous Knowledge for Agriculture and Rural Development (CIKARD) and the Leiden Ethnosystems and Development Program (LEAD) (1987) (Warren 2011). When the Institute for Ethnobotany and Zoopharmacognosy (IEZ) in the Netherlands was founded in 1996, the IEZ joined 32 other established centers, four universities with IK study groups and another 20 centers in their early stages of formation (Warren 2011).

The 1996 McCorkle/Mathias book on EVM established the field academically. It was recognized as very significant by the World Bank. The editors, in particular, German veterinarian Evelyn Mathias, always emphasized that EVM is not just about herbs. To her the context of animal care, with its own values and philosophy, is just as important. The authors in this work were scientists, veterinarians, and anthropologists working for NGO's who were concerned with participatory research and the empowerment of local communities. Of the 23 chapters, 11 have a female first author. The pioneers in this field stress the importance of the context in the healing process, involving many more aspects than just the (herbal) medicine administered. There is much attention paid to certain rituals, for example, healing songs. The participating research methodology with its purpose of strengthening local rural communities was also promoted by Cheryl Lans (2001) and used by the IEZ for their EVM surveys (Van Asseldonk and Beijer 2006).

EVM has no specific society or journal. The most obvious peer group we see is in ethnobotany and ethnobiology. Human ethnomedicines and ethnoveterinary medicines are complementary rather than separate fields (Lans 2001). Ethnobotany has had for several years chairs in universities in Europe and the United States. These chairs are mainly related to botany/taxonomy or to anthropology departments. The difference in scientific embedding can reflect itself in methodologies and ethics. As an interdisciplinary science, ethnobotany often involves other disciplines like pharmacology, pharmacy or pharmacognosy. Veterinary faculties are often involved in EVM.

General EVM research, describing the traditional practice, is mainly published in the Journal of Ethnopharmacology (Table 7.1), the Journal of Ethnobiology and Ethnomedicine, and, to a lesser extent, veterinary journals such as BMC Veterinary Research, Veterinary Parasitology, and Veterinary World. After the last turn of the century, EVM publications in social science journals have become rare. This may be the reason that EVM studies that could contribute to the growing discipline of Feminist Animal Studies have been ignored (Mayer et al. 2014). Selective citation practices have been discussed in critical feminist and anti-racist geographies and in other disciplines (Mott and Cockayne 2017). Mott and Cockayne (2017) write that:

> "To cite narrowly, to only cite white men, to form citation cartels (informal agreements between authors to continually cite one another's work) to boost 'impact,' or to only cite established scholars (the animal liberation movement's Peter Singer for example), does a disservice" to new scholars or non-white male scholars. It is important because citation can be used as a proxy for measuring impact, relevance and importance which plays a role in hiring and tenure decisions.

Maude (2014) goes further by stating that the need to prove academic credentials leads to academics referencing authors who do not mention gender or are opposed to feminist studies.

In 2010, a second EVM textbook was published, titled Ethnoveterinary Botanical Medicine. It was edited by two South African veterinary scientists (Katerere and Luseba 2010), and the contributions came mainly from vets and agroscientists. The book has 17 chapters, of which 7 have a female first author. It concentrates on the experimental pharmacological assessment of herbs used by indigenous people. The focus is much less on empowering local healers but mainly on the screening of herbal extracts for biological activity. Involvement of locals is reduced to the legal aspects of Access and Benefit Sharing as ordered in the Convention on Biological Diversity (CBD 2011) and in several national laws.

7.3 Cultural and Ethical Context of Ethnoveterinary Scientists and Practices

Talking about context, most people think of the informants' cultural group, their values and beliefs, etcetera, but the researchers' context is also important. Researchers may have a gender bias (Kidane and Maesen 2014), discussed in the next paragraph, and there will be an influence from their country of origin and closest peers.

For example, the IEZ (Dutch) context differs very much from German-speaking countries or India. Until the end of the last century, herbalism in the Netherlands was seen as a type of homeopathy; therefore, both ethnobotanical and ethnoveterinary

Table 7.1 Ethnoveterinary and folk veterinary publications included in pubmed 1994-2018

Year	Vet Paras	Country	J Ethno-pharm	Country	J Ethnobiol Ethnomed	Country	Other journals	Name of other journals	Country
1994							1	Rev Sci Tech	Japan, Croatia
1997	1	Global							
1998							1	Prev Vet Med	Trinidad and Tobago
							1	Ann NY Acad Sci	Uganda
2000							1	Ann NY Acad Sci	Burkina Faso
2001							1	J S Afr Vet Assoc	South Africa
2002			2	Tanzania, Kenya			1	Prev Vet Med	Nigeria
2003	2	Kenya (2x)	3	Kenya, Uganda, Italy					
2004							1	Vet Res Commm	Italy
							1	Parasitol	Kenya
2005			1	Pakistan			1	Anim Health Res Rev	Kenya
2006	1	South Africa	3	Pakistan. Kenya, Turkey	2	Italy and Mediterranean, Trinidad and Tobago			
2007	1	Canada	1	Ethiopia	1	Brazil	1	Trop An Health Prod	Trinidad and Tobago

2008			3	South Africa, Pakistan (2x)	1	Ethiopia	1	Res Vet Soc	Thailand
2009			3	Nigeria, Uganda, Pakistan	2	Brazil, Peru			
2010			1	Spain	2	Kenya, China	1	Pharm Biol	South Africa
							1	Afr J Trad Compl Alt Med	India
2011			3	Korea, Brazil, Kenya	2	Brazil, Argentina	1	Exp Parasit	Turkey
							1	Nat Prod Comm	Italy
							1	BMC Vet Res	Nigeria
2012			5	Brazil, India, Kenya, Spain, China	1	Kenya	1	Exp Parasit	Mozambique
							1	Vet Microbiol	South Africa
							1	eCAM	Catalonia
							1	Comp Clin Path	Iran
							2	Afr J Trad Compl Alt Med	Zimbabwe, USA

(continued)

Table 7.1 (continued)

Year	Vet Paras	Country	J Ethno-pharm	Country	J Ethnobiol Ethnomed	Country	Other journals	Name of other journals	Country
2013			2	India, South Africa	3	Pakistan, Ethiopia, W Sahara	1	Brit Poultr Sci	Turkey
							2	Exp Parasit	Brazil, Turkey
							1	Pastoralism	Cameroon
							1	Hom Org	Cameroon
							1	Biomed Res Int	Botswana
							1	BMC Vet Res	South Africa
2014			3	Brazil, Congo, Ethiopia	2	Ethiopia, Swiss	2	Asian Pac J Trop Biomed	Burkina Faso, India
							1	Afr J Trad Compl Alt Med	Tunisia
							1	Biomed Res Int	Pakistan
							2	BMC Vet Res	Ethiopia, South Africa
							1	Sci World J	Pakistan
							1	Iran J Vet Res	Pakistan
							1	South Afr J Botany	Namibia
							1	Complem Med Res	Europe
							1	Pharm Biol	Ethiopia
2015	1	UK/ Ethiopia	4	Serbia, Brazil, India, Pakistan	3	Zimbabwe, Romania, Algeria	1	Acta Med Hist Adriat	Servia
							1	J Trad Compl Med	India

							1	J Vet Med	Nigeria
							3	Vet World	Benin, Tanzania, Ethiopia
2016	3	Brazil, UK, India	7	Romania, Austria, Turkey, Cameroon, Palestine, South Africa, Canada			1	Rev Biol Trop	India
							1	Onderst J Vet Res	South Africa
							1	BMC Compl Alt Med	South Africa
							1	Brazil J Pharmacogn	India
2017	1	Brazil			6	Tanzania, Nepal, South Africa, Belarus (2x), Pakistan	1	Molecules	South Africa
							1	Pharm Biol	Zimbabwe
							1	BMC Vet Res	Ethiopia
							1	BMC Compl Alt Med	South Africa
							1	Sci World J	South Africa
							1	Iran J Vet Res	Iran
2018 (Jan and Feb)			3		1	Pakistan	1	Trop An Health Prod	Nigeria
							1	Vet World	Zambia
	10		44		26		58		

research was neglected or very much biased. Farmers that wanted to try herbs often got homeopathy. Vets that wanted to use herbs were attacked by the Quackwatchers society. The one and only Dutch veterinary university is very skeptical about herbs. Lack of education in systems that work with other paradigms makes the vets that are interested in alternative approaches very vulnerable to "bullshit-therapists."

Recent research shows that complementary and alternative medicine (CAM) is dominated by female practitioners and consumers (Keshet and Simchai 2014; McCorkle, 1986). Women have turned their traditional caring roles into CAM-related careers and possibly because of this CAM is constructed as "soft" and "feminine" versus "hard" science and biomedicine (Keshet and Simchai 2014). The attacks by quack watch societies on alternative medicine are therefore attacks on women and their knowledge and the minority of male practitioners working with CAM who tend to specialize in areas that require anatomical mechanical training such as chiropractors and osteopaths.

One of the research methods that was pioneered by IEZ staff members is called the school essay method. It was used as a means of gathering data from the entirety of a small country. The method came out of participatory action research (Sutton and Orr 1991). At the time there was no other English reference to use and if the thesis supervisor had not been very well established and well regarded and an Extension/RRA/PRA expert, the method might not have entered the academic literature. At the IEZ, EVM research was also done with the help of students and scholars. This has limitations, but also advantages, such as love for the subject and a thorough participation of the informant group coupled with an ethical and contextual grounding for the research (Fig.7.1).

Researchers that have less in common with informants, often interview them with the purpose of assessing the information they can extract from them. They prefer the experimental validation of the registered remedies ("to separate false from true").

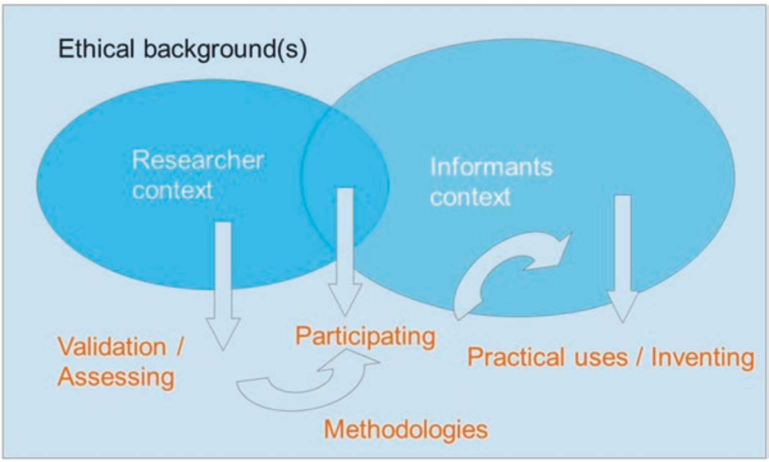

Fig. 7.1 Feedback loops in participating EVM research

This probably has to do with a preference for the "hard, experimental" approach above "soft, theoretical" science. This preference goes back to the sixteenth century founder of empiricism Francis Bacon, who stated that nature should be tortured like a witch at a trial for a yes or a no result. Results of the assessments are often negative or else at best "promising." For example, in the Netherlands, a traditional treatment of horse colic consists of giving the horse a few peppermints and taking it for a walk until there is defecation. If the report of this treatment is only a part of a long plant list stating *Mentha piperita* oleum, it does not capture the whole procedure and a clinical test of only the plant will be disappointing. If the researcher only focuses on the toxicity of the remedies using chemical extracts that are not based on the traditional aqueous approach, the result may be the banning of a traditional remedy, or expensive demands for value chains and quality control (Booker et al. 2012). The small herb farmer cannot cope anymore.

Reductionism should make way for systems theory (Warren 2011). There is a large number of lesser known traditional medicinal philosophies that EVM should include in their scientific reports (Van Asseldonk and Lans 2016). Shankar et al. (2007), scientists at the Institute of Transdisciplinary Health Sciences and Technology, advocate the development of intercultural standards for quality, safety, and effectiveness in relation to traditional healing systems. Each traditional herbal medicine system in time develops its own internal quality standards in areas such as sowing and harvesting times, collection, and processing. This also includes qualities that along other (subjective) ways are reflected such as in aromas and flavors and in the classic humoral classifications hot–cold, centripetal, or centrifugal working, and so on. An important aspect of traditional medicine is also that almost all of these cures work with a combination of drugs and non-pharmacological interventions. Other research methods besides the traditional RCTs are needed, says Shankar et al. (2007). The cross-cultural cooperation between bio-medical scientists and experts on traditional knowledge cannot be left out. The identification of a traditional plant used should not only be done by a biologist/systematist—the experts in the healing tradition must also be involved.

However, the danger now exists that large ethnopharmacological databases are built with the sole purpose to develop drugs much faster through molecular docking and high throughput screening technologies. These drugs are developed outside their original context and therefore provide disappointing results. In this way biopiracy will merely enter a new stage, when Indian scientists, for example, Biswas (2015) "sell out" ayurvedic knowledge. From an EVM perspective, the failure to listen to women's and small farmers' knowledge of benefits of herbs and the ways to maintain and increase the farm diversity have contributed to multiple problems. Male agriculturalists have been obsessed with the removal of weeds. Now that organic farmers and animal welfare concerns have brought cows back to pasture lands with greater biodiversity, arguments are getting stronger that this improves health (Laldi 2012a). Now academics attached to production models based on complete control of Nature have responded by trying to frighten funders and write about cattle exposure to "compounds of concern" (Van Raamsdonk et al. 2015). An all-time low is reached when scientists use their "authority" to frighten people from their traditional herbal use by identifying potential hazards not yet studied (Van Andel 2016). This is a quick and dirty way to obtain research funding.

When the context and anthropological aspects are undervalued or neglected does the research benefit the host community? This question was addressed by three female ethnobotanists/scientists in the 100th Anniversary edition of the Journal of Ethnopharmacology and the outcome was very poor (Etkin and Elisabetsky 2005; Jäger 2005). The code of ethics (COE) of several ethnobotanical societies (visible on the Societies of Economic Botany (SEB) and Ethnobiology (ISE) websites pay much attention to the rights of indigenous people for benefit sharing as formulated in the CBD. Guidelines for the ethical behavior of their scientists have been developed by the ISE (2006–2008). The SEB adopted this code in 2013 (at their 54th Annual Meeting). The code focuses on relationship building and includes free, prior informed consent and benefit sharing. It was recognized that this is an ongoing process with potential for continual revision (Willcox et al. 2015). The ISE code of ethics is based on the CBD, that is, now ratified by 98 countries (remarkable exceptions are Italy, US, Brazil, Russia, and Australia). The CBD talks mainly about access to and profits from genetic biodiversity. This is too small a focus. ISE made an interesting tool-kit to go with this COE that says (e.g.):

- Researchers should explore ways to promote benefit sharing. One example is to allocate funding in research grants to the community to enable participation in conferences.
- Researchers could submit papers to the community for local peer-review. This involves co-management of research and researchers may lose some control of the project in this scenario. However, this can also lead to a profoundly different and better understanding of the research material.

Nowadays, it is good practice, for example, in India where much EVM fieldwork is done, to publish with each remedy the person that helped to include it in the study (often a traditional healer). It is a way to prevent biopiracy. Also traditional medicine is not a static thing (Patwardhan 2008). Sure it has its own epistemology, assumptions, hypotheses and methods, quality standards, and parameters. But it is no monument, it is an evolutionary sector that increasingly incorporates new techniques. Like conventional medicine, indeed, but all too often this is not recognized by scientists that write down sentences like: In the XYZ culture the belief is that ABC is the result of DEF and it can be cured by PQR. A culture is not a museum. It can be better compared with a growing tree (Fig. 7.2).

EVM researchers should not see themselves as professionals that gain their money by transferring indigenous knowledge from one (part of a) culture to another without having to question their own paradigmatic context. This leads to an often useless transmission of knowledge with a lost context.

In the future, ethnoveterinary researchers need to distinguish between what plants are being chosen by animals, which plant uses are the result of new experimentation by animal owners and which plant uses are (new) ways of using the previously published cultural traditions of specific groups (Lans 2016).

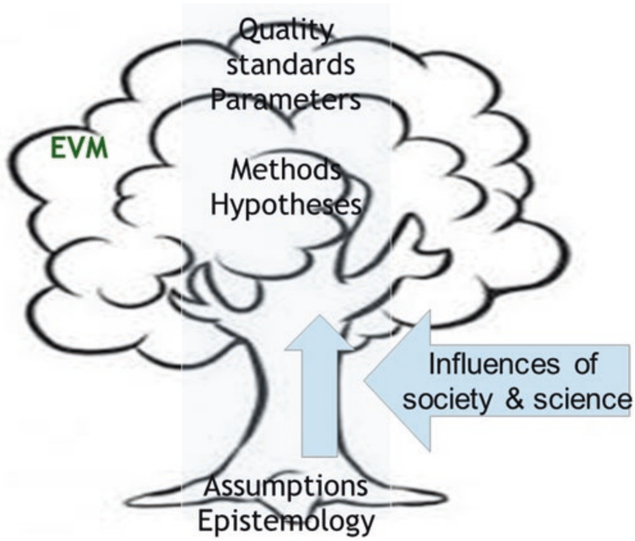

Fig. 7.2 The “tree” of culture

7.4 Feminist Animal Studies

Academic vegetarians and vegans have gravitated to the relatively new field of Feminist Animal Studies (FAS). FAS is part of Animal Studies and Human-Animal Studies which consists of scholars in the humanities and social scientists who have “turned to the animal” and are concerned with animal suffering (Gaard 2012). For example, MacKinnon (2004) claims that animals want to be “let alone” and separate themselves from human society. Gaard (2012) writes that three prominent academics gave the field of Animal Studies academic respectability, and decries the failure of Animal Studies scholars to cite animal ecofeminists and vegan feminists. Ironically, FAS scholars such as Deckha (2012) and Geiger and Hovorka (2015) obtained funding to “turn to the animal” and ignore the women already working in the EVM field who have studied wild animals as part of zoopharmacognosy research or know informants who may have helped to heal wild animals whose treatment by veterinarians was too expensive (Lans 2012). A study of EVM would have shown FAS scholars that different cultures have different concepts of animal welfare. Tzotzil Mayan women take good care of their sheep, considering them to be soul mates (Perezgrovas 1996). Therefore, considerate care is not linked to economic status as claimed by the FAS scholars Geiger and Hovorka (2015) who looked at donkeys in Botswana.

Just like young feminists use Internet posts to overcome invisibility and silencing, individuals have posted Internet videos undermining FAS academic arguments and showing that even wild animals have some knowledge of human society (Munro 2013). For example, a fox with a jar on its head approached two

Russian men on a dirt road for help (Lawson 2013) and a wounded elephant shot by poachers went to the Bumi Hills Safari Lodge in Zimbabwe for help (Staff 2016). In 2014, pods of dolphins joined in the Rincon Classic surfing competition in Santa Barbara, California and in the J-Bay Open in Jeffreys Bay, South Africa (Bloom 2014; McQueeney 2014).

The Jainism advocated by FAS scholar Aristarkhova (2012) is followed by a minority of people and its strictures regarding the treatment of other living beings including animals are impossible to follow and go against Nature. It is not possible to harvest crops, plant seeds or pick fruits without harming insects and worms. To follow Aristarkhova's portrayal of Jainism means the end of plant-based agriculture. The ethical commitments Aristarkhova outlines are not only impossible, they are ridiculous. The entire premise rests on the erroneous assumption that plants do not have feelings or cognition so it is more ethical to have a plant-based diet.

Aristarkhova's epistemic irresponsibility involved the harvesting of trees to publish an impossible ethic of care (Nelson 2009). Aristarkhova (2012) is actually setting out an ethic of detachment, trying to remove humans from nature and force them into a life of the mind. Aristarkhova (2012) also avoids all mention of the ways that wild animals live their lives. In some cases, domesticated animals have a greater opportunity to reproduce in captivity than they would living in a natural hierarchy where only the "top dog" is allowed to reproduce. A domestic animal has none of the daily concerns of becoming a victim or having to be a killer. Slaughterhouse rules have been revised considerably in response to the justifiable concerns of animal welfare specialists.

Vegans and vegetarians are arguing via feminist animal studies that their own dietary individual preferences should be followed by the far larger population of meat eaters. Another argument in feminist animal studies is that the abuse of women and animals is linked in an essentialist way. Feminists should not allow their lives to be dictated by the reasoning of patriarchal men who link women and animals together as lesser beings. Women have probably ridden horses away from abusive situations. Other women have probably been protected from attackers by their dogs. Feminism has successfully made the case that animal abusers should be arrested with the consideration that they may later go on to abuse people. It is a bit disconcerting for MacKinnon (2004) to focus on a minority of perverts abusing animals and ignore hundreds of millions of women working with and keeping animals. Perverts abusing animals are a matter for the [feminist] law.

7.5 Gender Involvement and Ecological Context of Ethnoveterinary Practices

The field of EVM has always involved women, both those taking care of small livestock and dealing with internal parasites and reproductive issues and those recording and disseminating the practices (McCorkle 1994; Davis et al. 1995; Ghotge et al. 2002; Mathias-Mundy and McCorkle, 1989). When Perezgrovas (1996) conducted research on the EVM of the Tzotzil Maya Indians, he had to take a young girl with him because the culture did not permit him to talk to the women directly. EVM has often made use of participatory research methods (Waters-Bayer 1994) similar to the ones published by feminists in the 1980s and 1990s (listed in Lans and Roling (1998), also Waters-Bayer 1994). However, journals in the EVM field are dominated by male editors and authors.

Professor Patricia Howard published and lectured at the SEB in 2013 about the gender bias in ethnobotanical publications in the Journal Economic Botany (Howard 2006, 2013). She argues that the knowledge and use of plant biodiversity is everywhere gender-differentiated and that women's knowledge and management of plant biodiversity are underestimated and undervalued. Of this, she gives several examples. On the other hand, researchers from Brazil (Torres-Avilez et al., 2016) argued that there is no gender-based pattern for medicinal plant knowledge (neither local nor global). Based on 61 out of 194 studies that mentioned the gender of the informants for the documented plant species, it was concluded that men and women had equal knowledge of plants. However, the possibility of a gender bias in the researchers of the studies was not considered.

In EVM studies in Ethiopia, researchers and informants were almost always males (Giday and Teklehaymanot 2013). Either Ethiopian women have no knowledge of medicinal plants or they will not talk about it in the presence of males. Still, the care for (sick) animals is in many parts of the world a female activity (Mwangi 1996; ILRI 1999). In the US and Canada, there were 50% female veterinarians in the 1980s and in 2017, 80% of veterinarians were female (Kelly 2017; Lofstedt 2003). In Europe, there is equality between the sexes with the female percentage increasing rapidly (FVE survey 2015). Studies conducted in the United States provide some evidence that feminization affects the economic well-being of the profession in a negative way (Lofstedt 2003). The veterinary paramedic assistant is in nearly all cases a woman. In spite of all this, ethnoveterinary research is taught in Indian, South African, Namibian, and Ethiopian Universities by men.

Just like the science of ecological thinking outlined by Code (2008a), ethnoveterinary medicine (EVM) works with animals through their carers, meaning that feminist ethics of care toward animals include the human–animal interface (Donovan and Adams 2007). EVM involves a basic commitment to do what is best for animals *and* their environment. In our EVM methods, we practice the epistemic responsibility that Code (2008a, 2008b) asks for and describes as answerability for something and a commitment to "stand behind" people, their health, and the health of their animals.

Often we find among local healers:

- Holistic thinking about mother earth and the local ecosystem as the nurturing habitat/home of all living creatures;
- Caring about sick persons and animals is more important than "miraculous" cures.

Geerlings (2001) found that Raikas in south-central Rajasthan visited temples to pray for their sheep's welfare and health. Mantras and tantras were chanted for sick sheep and many animal sheds had small niches with altars built into the walls.

Ethnoveterinary medicine enters into debates on disease control on a global scale as it becomes more integrated into "participatory epidemiology" which seeks to improve epidemiological surveillance in remote areas and encourage community participation in disease control (Mathias 2004; King, 2004). We think this focus has been under-developed in the contemporary EVM scientific community.

7.5.1 Ecological Context

Caring about herbs and implementing herbs in farm management will often lead to an increased biodiversity. Dutch greenhouse industry looking for innovation tries to develop forward to energy-producing (instead of fossil energy consuming) greenhouses. And there is a lot of interest in changing or adding herbs to their horticultural activities. Herbs can also reduce the need for pesticides, as several medicinal plants are plague insect repellants and others attract useful insects. Therefore, IEZ was in 2009–2010 involved in the project *Medicines from the greenhouse*, funded by the Dutch Ministry of Economic Affairs. It was a desk study into the economic potential for Dutch greenhouse growers to cultivate wellness/health food and medicinal plants in cooperation with a specialized herb breeding farmer (Van Kasteren et al. 2017). Also, a database of well-researched properties of medicinal plants (www.infofyto.nl) was created. Due to EU legislation, farmers could not sell their herbs with the site so created. Also the smaller herb farmers are drowning in the ever more expensive quality tests on toxicology, microbiology, alkaloids, etcetera. At this moment, IEZ is trying to set up a community lab with several small organic biodiverse herb farmers to cope with these demands.

Farmers' groups showing ever more interest in herbs are for example pig farmers. IEZ worked with them showing a good influence on meat taste and behavior (Van Asseldonk, 2005, 2012a). Other important groups are dairy farmers. In 2010–2011, the Laldi MSc study (2012b) included 22 dairy farmers and pointed at correlations between animal health and pastures rich in beneficial herbs. Methodology for the ethnoveterinary part (interviews, see Laldi 2012c) and support in defining beneficial herbs came from IEZ, that did a parallel zoopharmacognosy study at four of these farms, but this support was uncredited. Laldi found that cows grazing on pastures with the most herbs (Medicinal Herb Enriched value MHE) needed the least amount of antibiotics.

In 2012, IEZ supported a group of (mainly goat) farmers that had acquired funding from the Dutch Ministry of Economic Affairs and the European Agricultural Fund for Rural Development (EAFRD). This project focused on the introduction of fodder-trees (voederbomen; project site www.voederbomen.nl). The group wanted to know more about the medicinal value of the circa 50 trees and shrubs they were considering for planting on their farms. IEZ analyzed their list and pointed to the medicinal compounds such as salicylic acids in willow bark, isoflavones in hawthorn, digestive bitters in ash, etcetera. Farmers were very interested in the medicinal aspects of the tree consumption. IEZ advised them to plant if possible trees with a diversity of medicinal compounds, offering the animals the opportunity to balance their health, thus reducing the need for medicines (Van Asseldonk 2012b). Small trees with low branches can be used by the animals to self-medicate, else they can be harvested by women and children. Tree trimmings can be turned into chips and used for green energy. The new feeding practice can reduce the excessive leaching of minerals from manure into the soil. The ecological benefits of these type of projects can be enormous.

Ethnoveterinary medicine (EVM) becomes even more integrated with feminist concerns when it seeks to protect the backyard chickens of the poor from needless slaughter during debates on ecosystem health. Ecosystem health is the study of the interconnections and relationships between livestock, environment and human health. In 2005, the spread of avian flu was blamed on wild birds, free-range, and backyard poultry. Backyard or family poultry are owned and cared for primarily by women and children and provide a critical source of food and income for people in developing countries. They are kept in increasing numbers in developed countries as a source of organic eggs and a means of using kitchen scraps. Rather than ask EVM specialists for their input, Louise Fresco, Assistant Director-General of FAO (cited in GRAIN, 2006 and in IPSNews 2005) claimed that: *The backyard chicken is the big problem and the fight against bird flu must be waged in the backyard of the world's poor.* Fresco has been President of the Executive Board of Wageningen UR since 2015. It was an NGO that showed that the spread of avian flu could be linked to the development of industrial poultry farms in Asia, and their use of common transportation routes (GRAIN 2006). When traditional strategies that are being used for the control of unspecified respiratory disease in EVM could be evaluated for their effectiveness against avian influenza, this would be both an environmentally and socially sound approach.

7.6 "Modern" Ethnoveterinary Science

Most recent EVM publications start with a general geological description of the study region and its vegetation. They produce a long list of plants that are used for certain ailments. This inventory (completed with a "coefficient of saliency index," Informant Consensus Factor (ICF) values and Fidelity Level (FL) values) is eventually followed up by pharmacological tests that confirm for at least a part of the plant extracts some bioactivity. The Western medicine paradigm uses a simple cause–effect model of sickness and its (chemical or chirurgical) cure, whereas traditional systems talk about curing the sick and the environment alike; this is for many practitioners the same thing. EVM holistic procedures are often not linear cause–effect organized but have a more cyclic approach, where context factors such as time of day, year or life are important. One cure fits all individuals is a dream of many Western scientists and that is where the funnel of Fig. 7.3 leads.

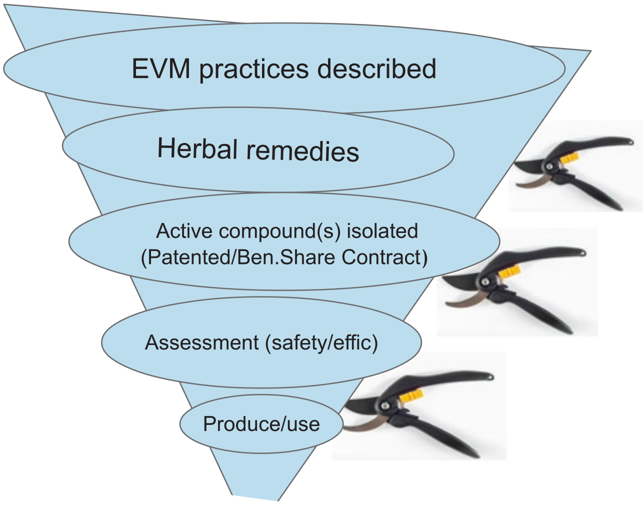

Fig. 7.3 Step-by-step reduction of observed complex ethnoveterinary practices to molecular compounds that fit in a Western pharmaceutical disease approach

7.6.1 Ethiopian Example

In a cooperation of WUR (one female/one male) and Addis Ababa (two male), the scientists (Kidane and Maesen 2014) write: "We studied and analysed the traditional medicinal plants used for the treatment of livestock diseases by the Maale and Ari ethnic communities in southern Ethiopia. The respondents' group was composed of 41 males and 33 females. In all study sites, male respondents knew more plant species: in Maale male: female was 6.7:2.0, in Ari 13.6:0.0, and in Ari 21.6:1.1." Researchers write: "This could be attributed to the favoring of sons in knowledge transfer and also the perception of the communities that dealing with livestock is the task of men. This may affect the future conservation of medicinal plants especially in home gardens, as women play a major role in tending these gardens." A puzzling remark that leaves a lot of questions open. The predominance of male researchers and male respondents is seen in other Ethiopian research (Feyera et al. 2017; Eshetu et al. 2015; Kidane et al. 2014).

A group of four male Belgian and Ethiopian scientists did an EVM field study in the Ankober District of Ethiopia (in the North) (Lulekal et al. 2014). The number of informants involved in the ethnomedicinal survey was 352 (235 men and 117 women). Both sexes reported ca 4 plants/person on average (that seems to be a very low number for herb experts). Semi-structured interviews, focus group discussions, participant observation and walk-in-the-woods were used to collect data. These walks gave opportunity for more discussion with individual informants. Informant Consensus Factor (ICF) values were calculated, but the philosophical context in which these plants were used remains undocumented. Informants are thanked for their openness, but what they get out of it remains unclear.

Eshetu and three other (male) scientists from Dilla University, Ethiopia, published in 2015 an EVM study report (Eshetu et al. 2015) concerning four districts with different culture and languages in southern Ethiopia. They selected 31 traditional healers (27 males and 4 females) purposively based on the recommendation from local elders and governmental bodies. The report states: "The healers had a very high intention to keep their traditional knowledge secret and none of them was ready to transfer their knowledge either freely or on incentive bases to other people; they need to convey their knowledge only to their selected scions after getting very old." Nevertheless, a total of 49 plant species used to treat 26 animal ailments were botanically classified.

These Ethiopian studies in our vision raise some ethical questions as mentioned in paragraph 3. It seems noteworthy that male researchers talking to qualified Ethiopian healers get so little information on the plants they use. Female respondents (if any) mention few or no plants. But also male informants mentioned on average (much) fewer than ten plant species. Feyera et al. (2017) again experience in Ethiopia that male informants gave more than 90% of the information. They write: "The way traditional veterinary medicine is acquired by the practitioners is largely similar to traditional human medicine. The traditional healers claimed that there is a considerable overlap in the utilization of some of the reported herbs against both human and livestock diseases. It was also interesting to note that most of the sampled ethnoveterinary practitioners were also traditional healers for several human ailments."

To us it seems rather unbelievable that professionals in herbal healing would know the use of so few plant species. In all of these examples, we miss an anthropological approach and a real involvement with and description of the local traditions. Also, the question if there is gender bias involved needs further consideration. Still none of the studies recommended anthropological or female involvement in a follow-up.

7.7 Methodological Remarks and Suggestions

In Sects. 7.3 and 7.5, we have stressed the importance of participatory research such as that described by Lans (2006, 2007a, b). The Dutch Fyto-V project (Groot 2008–2018; Van Asseldonk 2010; Groot et al., 2011, 2013) was partially based on the methodology outlined in Mundy and Mathias 1997. Also the IEZ field studies (Van Asseldonk and Beijer 2006) used students interviewing peers. Each student had to document at least two herbal remedies using partly structured interviews. They all asked at least the information for the IEZ database (Plant (part), animal, preparation, dose, indication, source(s), and results). The informants were mainly neighbors, friends, family, etcetera; this means there was no question of mistrust. Still we made it clear that students should treat informants respectfully and may not claim copyright that belonged to the information providers (although we kept the latter anonymous in the reports).

When IEZ was asked to teach veterinary phytotherapy to naturopathy students and vets, together with the students, an inventory was made of herbal home remedies that were still in use in the Netherlands to have some kind of baseline because it was suspected that these new professionals would change the existing EVM practices (Van Asseldonk and Beijer 2006).

Organic farmers asked for the IEZ's help with a herbs-for-farm-animals project (Van Asseldonk 2005) and this led to the so-called Fyto-V (www.fyto-v.nl) project. It was funded by the Dutch government and coordinated by Maria Groot of RIKILT-WUR from 2006 to 2008. The full name of Fyto-V is *Development of phytotherapy as a tool for reducing and/or prevention of diseases in farm animals*. The goal of the project was to increase the number of available herbal and natural products that organic farmers could use for animal health and to replace the use of antibiotics in conventional livestock farming (Groot 2013). The IEZ worked on literature databases, a website, interviews with farmers and designing and evaluating animal experiments. Experiments were conducted, mainly at WUR, on 11 of the 142 products derived from 255 formulas gained from industrial parties and academic institutions and from traditional knowledge. Three were pig growth enhancers, three were for udder health in dairy cows and five were used against coccidiosis in poultry. This project produced guides for the use of natural products by farmers (partially based on the methodology outlined in Mundy and Mathias 1997). These guides were requested by the farmers and are a core feature of participatory action research (Groot 2008, 2011).

The IEZ has lost out on funding to people who know less about EVM than we do, and the research by the non-experts has sometimes proved disappointing. Our situation fits Lorraine Code's (1995) work on who counts as a knower. The IEZ is an NGO (or a Small and Medium Enterprise (SME) in Europe) which hampers its ability to be recognized as a research pioneer by University faculty (unmentioned in the EU etvet summary by Mayer et al. 2014), and its ability to attract funding (funder bias Noss, 1997). Funding then goes to larger universities with non-expert (male) staff who make mistakes. A few examples, both for non-experimental and experimental validation are given below.

Non-experimental validation was shortly described by Lans 2007a, b as applied anthropology. You definitely need to have an interdisciplinary team; in case of EVM, this will include a vet, a pharmacognosist, an anthropologist (that did the fieldwork) and of course local expert(s), coming from your informant group. Also you need a trained herbalist if she is not yet in the group. The advantages of this method are clear: low costs for one thing and the informant group (in most cases the farmers) benefits directly from the process.

There are also some disadvantages to this method:

- The Western world accepts experimental work better.
- The method cannot be applied for unique local recipes.
- If the validation is done by non-experts you can get useless results.

For example, *Titrie* was reported as an unknown product in an EVM survey of CVI (NL) (Kijlstra 2004). An expert would have known that the informant meant Tea tree, *Melaleuca* sp. (Lans and Van Asseldonk 2013).

Experimental validation is widely accepted but can also typically bring a few problems if the informants' group and herb experts are not involved:

- In a test for anthelminthic effects of herbs for pigs (Van Krimpen et al. 2010), papaya fruit juice was used instead of the traditional remedy papaya latex; therefore, WUR researchers found no effect; also there was a mix-up of the pharmacologically very different *Artemisia* species, so in fact research money was spent in vain (Lans 2011).
- Another problem may be that the animal model has to be as cheap as possible (lab animals are expensive!) and therefore researchers want a huge and reliable difference in effect (e.g., a 7% increased growth with an s.d. of 1%). More than once we came across research reports which stated that herbs were totally ineffective because the probability for a chance outcome was around 10% and not 5% or below. In real life however we would bet our cards on the 90% and so do most farmers.

Involving systems biology could be a next fruitful step. Much can be learned from researchers that evaluate TCM (Wang 2005, 2009) or Ayurveda plant combinations for complex disease processes, using techniques of systems biology (Padwardhan 2008). There the holistic concept of correction of imbalanced situations, instead of just killing pathogens or overruling certain body functions, is better respected and recognized.

7.8 Conclusion

No one has to ask if EVM "has been good for animals" as Gaard (2012) asks about Feminist Animal Studies. Our basic commitment to do what is best for animals and their environment is perhaps what divides us from vegans and animal rightists who want animals to live apart from humans. Because of our field-based experience we know that some animals do not seek separation from humans as claimed by MacKinnon (2004).

The photographs in Fig. 7.4 are my (CL) attempt to document some of the wildlife I have encountered on farms and in towns in response to MacKinnon's (2004, 325) erroneous assertion that animals want to be "let alone" and separate themselves from human society. We showed examples of EVM research in relation to contextual, environmental, and gender issues, stressing the importance of the context in which healers and researchers operate. In this interdisciplinary science, the input of women scientists is essential, because the relationship with the informants, in many cases female farmers, needs mutual trust and respect. The focus in EVM should not be restricted to the "hard scientific" pharmaceutical results. A broader focus on gender aspect as well on the environmental and cultural context of EVM issues is needed.

Fig. 7.4 Examples of wild animals seeking human company. (**a**) A deer grazes fallen apples in Crawford Bay, BC; (**b**) a coyote visits a hobby farm in Rossland, BC; (**c**) geese visit a lakeside park in Penticton, BC; (**d**) a marmot waits close to a wine vat for me to leave so that it can go back to eating alfalfa in a Cawston, BC vineyard; (**e**) a raccoon waits to steal cat food at a horse stable in Delta, BC; (**f**) a normally shy otter came onto the dock, not to eat, but attracted by my damp, smelly pants in Pedder Bay, BC; (**g**) deer eating felled branches with moss in the foreground, noisy landscaping machine working in the background in Pedder Bay, BC; (**h**) after a long winter a porcupine comes (even by day) near the house where a path was made in the snow—there he finds fresh green. (Photographs: **a**–**g** = Cheryl Lans; **h** = Tedje van Asseldonk)

Some suggestions that we have for ethnoveterinary researchers, including ourselves:

Let's share our results, and also our failures.
Let's be aware of the informants' context, and of our own (biased) context.
Let's be clear about our motives and ethical background.
Let's include informants and traditional healers in our teams and funding.
Let's recognize there is wisdom outside the universities and outside our own brains.
Let's include zoopharmacognosy in our journals and societies, as the observation of wild animals is often the inspiration for herb cures.

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Chapter 8
Toward a Better Understanding of African Ethnoveterinary Medicine and Husbandry

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Keywords Ethnoveterinary · Holistic approach · Tradition · Community

8.1 Western vs. African Traditional Medicine: A Bit of History

The Western world began to show some interest in African medicines during the colonial period, but mostly just on anthropologic and ethnographic bases. As a result, at the time of the so-called *Green Revolution*, partially coincident with the decolonization process for many African countries, the full adoption of Western medicine in both human and animal fields was an unquestionable credo. In that period, as witnessed by the large and uncritical diffusion of the word *modernization* (Tipps 1973), the pathway to development undertaken by Western countries was commonly agreed as suitable, not to say the only possible one, for any society in the world (Bernstein 1971). The most famous source of this uncritical thought was the public discourse of US President Harry Truman, held in January 1949 as the inaugural address of his presidency: after the huge tragedy of World War II, and before the threat of the incipient Cold War, the *Truman Doctrine* (Merrill 2006), whose first statement dates back to 1947 (Spalding 2017), shows all the urgency to have a planet shaped as much as possible on Western values (Ogbonnaya 2016).

With this mentality remaining virtually unchallenged for two decades, it is no wonder that many possible outputs coming from African traditions were emptied of any practical significance and reduced to mere folklore. In fact, while the term *ethnobotany*, coined by the American botanist John William Harshberger, had already existed since the late nineteenth century (Harshberger 1896), the scientific world began to talk of *ethnopharmacology* (Holmstedt 1967) and *ethnomedicine* (Hughes 1968) only toward the end of the 1960s. Then, we had to wait almost

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20 years to start hearing about *ethnoveterinary*, a word coined by the American anthropologist Constance McCorkle. It is noteworthy that, despite her social sciences background, she immediately stressed the practical outputs expected from the subject (McCorkle 1986).[1] However, although there was sensitive support received from the German veterinarian Evelyn Mathias Mundy, she had to challenge the strong skepticism shown by a large part of the scientific world. In this sense, a paradigmatic example was the hefty criticism expressed by the veterinarian Robert Imrie on the *"Task Force for Veterinary Science"* website, affirming that *ethnoscience* was nothing else but *anti-science* (Imrie 2004). After some time of sterile confrontation between skeptics and enthusiasts, the practical field of application solved the matter: both Western and traditional veterinary medicine showed pros and cons, mainly depending on the specific concrete situation. Therefore, the better solution was to consider them as two complementary sets of tools to be used, and possibly matched, according to common sense and professionalism. That is to say: the choice between them must always be strategic and never ideological, an attitude that often results in a combination of the two systems. An important recognition has been recently conferred by the World Health Organization (WHO), which devotes an entire chapter to traditional medicine in the 11th version of the International Classification of Diseases (ICD-11).[2]

8.2 Avoiding a Starting Bias

Of course, for a proper selection of tools issued from two complex sets, an adequate approach is necessary. Unfortunately, very often it is not the case. For researchers and professionals graduated in formal institutes, the main bias comprises putting Western ideas at the center and evaluating traditional ones through similarities and differences from that. Such a mistake embraces all issues related to *modern* versus *traditional* confrontation when we stick to our position of "modern" (graduated) researchers and we observe differences that "traditional" (frequently illiterate) communities show compared to us. For instance, it is impossible to understand something about African sculptural art if we base our analysis on ideas issued from the European Renaissance, and also if we do not consider the field of symbolism and need to establish a dialogue with supernatural forces, which is strongly felt in the traditional societies of sub-Saharan Africa. In that geographical area, similarly to what happened in Europe in the periods preceding the Enlightenment, no field of knowledge can be separated from the supernatural.

[1] For a short review of the various definitions of the word issued in the 1990s, see: Zorloni (2017).

[2] The draft of ICD-11 was released in June 2018 and approved in advance by the 144th WHO Executive Board Meeting in January 2019. After final approbation by the 72nd World Health Assembly in May 2019, it will come into effect on first January 2022.

For medical matters, once considering Western medicine as the unique and "official" landmark, traditional human and veterinary medicine appear to be more or less suitable, depending on the degree of proximity and sharing with notions structured around an a priori credited line. Now, let us try to do the opposite.

8.3 Are Traditional Features Completely Absent in Western Medicine?

Around two and a half million years ago, at the time of the transition from the Pliocene to the Pleistocene epoch, human ancestors shifted their diet toward a significant proportion of meat (Pobiner 2013). Then, after being scavengers for a long period, humans became hunters around 500,000 years ago (Wilkins et al. 2012). A third step occurred with the Neolithic revolution, about 12,000 years ago, when human communities started to domesticate animals (Zeder 2008).

As witnessed by many prehistoric exhibits (Fuller and Grandjean 2001), the long-standing process of human–animal relationship development has been made more complex by the important role played by animals in religious matters.[3] Therefore, it is not surprising that humans have strongly endeavored to promote animal health and better husbandry since ancient times.

From the prehistoric age up to recent times, human and animal health care has been organized around some strong traits that can still be found today in traditional African cultures, such as a holistic approach to medical matters, openness to spirituality/religiosity, respect of tradition, and importance of community. Is all this foreign to Western medicine? Let us take a look.

8.3.1 Holistic Approach to Medical Matters

The holistic approach paved the way for all kinds of research throughout history. Until the eighteenth century, philosophy and medicine in Europe were considered to have a close relationship, as both were necessary for the preparation of a proficient doctor (Engelhardt 1976). In that time, many European veterinarians were just farriers with some practice in animal healing (Leclainche 1955b). Since then, medical and veterinary sciences have evolved a great deal. But even in the second half of the twentieth century, in rural areas of Western countries, both human and animal doctors, by virtue of their capacities in healing diseases, were consulted for any kind of suggestions. For the collective imagination, not unlike what happens today in many African communities (Mokgobi 2014), medical skills were strictly linked

[3] The German researcher Ina Wunn states that *"Homo neanderthalensis believed that the animal is a being quite similar to man, but talented with supernatural forces."* See: Wunn (2000).

to wisdom and humanity. Later on, with the spectacular advancement of new discoveries and the application of modern technologies to medical sciences, the role of human and animal physicians was strictly reduced to biological consultations, to the detriment of a multidisciplinary approach. In recent years, with the extension of medical technologies from the human to the veterinary field, many vets are obliged to specialize themselves, thus losing the multifaceted capacities that have so far characterized the profession.

In 1978, observing the restrictive sense by then attributed to the word "health" in Western countries, the WHO proposed a wider definition in the declaration of Alma Ata, where it is stated that health shall be intended as *"a state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity"* (WHO 1978). Moreover, at the beginning of the new millennium, WHO introduced the *One Health* approach, linking human health, food safety, control of zoonoses, and the fight against antibiotic resistance (WHO 2017). In this regard, the Office International des Epizooties (OIE) speaks of *"health of the ecosystems"* (OIE 2018).

8.3.2 Openness to Spirituality/Religiosity

The Greek physician Hippocrates of Kos (c.460–c.370 BC) is commonly reputed to be "The Father of Western Medicine" by virtue of his effort to separate natural causes of diseases from metaphysical superstitions. Nevertheless, his famous oath opens with an invocation to Apollo and the other deities thought to be involved in the healing process (Whiting 2007). Likewise, Claudius Galenos (129–210 AD) is considered the greatest physician of Antiquity after Hippocrates. In the Pergamon healing center (located in the present Turkey) where he worked, ritualistic preparations, sacrifices to gods, and priesthood roles were thought to be very important (Ustura 2007).

In line with the ancient centuries, the subsequent medieval millennium saw religious features considered of paramount importance for the healing process in all Western countries, with virtually all single human disease associated to a specific Christian Saint assumed as a protector. For academics and scholars, the Enlightenment of the eighteenth century seem to have laid down the ultimate separation of medical science from religion, but at folk level it was not the case. In fact, a large number of Westerners consider prayers and blessings as important factors in a healing or preventing process, even if a complete separation of the medical figure (human or veterinary doctor) from the religious one (priest or pastor) is normally agreed. In particular, Saint Anton is considered the patron of animals and every January 17th, in occasion of his celebration day, in many Western countries people bring both their pets and large animals to receive his blessing in specially arranged ceremonies.

In the last decades, especially after the research of Robert Ader and Nicolas Cohen on psychoneuroimmunology, published around the mid-1970s (Ader and Cohen 1975), the academic world acquired a more in-depth knowledge on the biochemical mechanisms linking human healing and faith (Koenig 2000).

8.3.3 Respect of Tradition

In common use, *tradition* is often opposed to *modernity*. On the contrary, the harmonization of the two terms has been asserted for some time (Gusfield 1967) and well documented inside (Gyekye 1997) and outside (Zonggui 2014) of the African continent. Yet, *"modernisation itself may strengthen tradition"* (Huntington 1971). What is more, despite some theories issued in the 1950s and 1960s suggesting a convergence of societies toward a common whole of modern values (Eisenstadt 1965), and despite big transformations occurring in the last years, even in present Europe *"values are still structured around a traditionalism axis"* (Galland and Lemel 2008).

Nowadays, contrary to the popular view that associates tradition to static and modernity to dynamic, we can assume that *tradition* is a package of knowledge and values continually evolving throughout transmission from one generation to another, in order to cope with the evolving situation of the milieu. In this sense, modernity is just the last aspect of the tradition and, being static, it is intended to become obsolete and disappear as soon as a new modernity rises up in the evolutionary cycle of tradition. Moreover, the high fidelity of the transmission, typical of traditions, allows the longevity of a culture, thus increasing the opportunities for cross-fertilization and combination of cultural traits promoting the development of knowledge and refinement of techniques (Enquist et al. 2010). Because of the importance of that long-lasting feature for the formation of a cumulative culture, novel inventions appear to be less decisive than *"small changes in the fidelity with which information is passed between individuals"* (Lewis and Laland 2012).

8.3.4 Importance of Community

This point is strictly related to the previous. In fact, in virtue of its size allowing an optimal combination of member interactions and mutual control, community can be considered the best repository of tradition. Sharing a physical space was the basic criterion for defining a community until a few years ago, while the recent development of technology in communication has raised new meanings, obliging many authors to wonder about the actual sense of the word (MacQueen et al. 2001).

The vital importance of communities in sub-Saharan countries, particularly in rural areas, has driven professionals involved in development issues to prioritize community-based approaches. Unlike what happens in the industrialized world, in rural Africa, the person does not make much sense in itself, but rather as a member of a community. And the community is not limited to the current people, but also extends to the ancestors who preceded them. As a result, health cannot be a personal fact, but it is considered a situation of harmonious balance between oneself, the other members of the community, natural resources, and supernatural ones. In this context, not respecting the rules can seriously endanger one's own health and that of one's own animals.

Concerning Western medicine, the importance of the communitarian level is highlighted in the Alma Ata Declaration, where the word *communit(y)(ies)* appears 13 times, particularly in 6 out of 7 points dedicated to Primary Health Care.

8.4 Relativizing the Historical Moment

Observing the matter with a more balanced eye, it is thus clear that the current concept of Western medicine should not be seen as an absolute reference term, but as an extraordinary level achieved by specializations in different fields of medical science. This is a general process started in the eighteenth century when scientists began *"to sacrifice rich concepts in order to promote rigor and clarity"* (Porter 1995). Since then, adopting a descriptive two-dimensional model, we can see that specialization in science reached higher and higher degrees, but at the cost of reducing its field of signification. As a result, any aspect not strictly related to a well-proven cause–effect relationship was discarded as it was deemed useless or even counterproductive.

The enormous benefits of this evolution in terms of health promotion are undeniable. However, as for every human process, we can never earn that much without losing something. Therefore, besides the huge advantages, we have to consider also negative aspects. Until the 1960s, the latter had not yet particularly emerged, so the absolute trust of the scientific world in Western medicine reached its apex. In 1962, Frank MacFarlane Burnett, winner of the 1960 Nobel Prize in medicine for his research on acquired immunological tolerance, wrote that *"at times one feels that to write about infectious disease is almost to write of something that has passed into history"* (Snyder Sachs 2007). Around 1967–1968, William Stewart Halsted, the then US General Surgeon, would have uttered his famous and unhappy statement (*"It is time to close the book of infectious diseases, and declare the war against pestilence won"*), actually as much mentioned as doubted (Spellberg 2008). By the way, 1967 is also the year of the first human heart transplant (Hoffenberg 2001).

Since then, some cracks have begun to form in the certainties of the medical-scientific world. While negative side effects and toxicity of drugs were more and more recorded,[4] antimicrobial resistance became an increasingly difficult problem. Penicillin had been discovered by Alexander Fleming in 1928 (Gaynes 2017) and resistance was first reported in 1940 (Abraham and Chain 1988), even before its mass use applied for treating wounded allied soldiers during World War II (Neels et al. 2017). In 1968, the UK Health and Agriculture Ministers instituted a *Joint Committee on the use of Antibiotics in Animal Husbandry and Veterinary Medicine*, directed by the biologist Michael Meredith Swann (Randall 1969). The year after, the Committee produced a report recommending to avoid the use, as growth promoters, of the same

[4] The most famous case was that of the teratogenic effects of thalidomide, already withdrawn from the market in 1961. See: Kim and Scialli (2011).

antibiotics employed for human or animal treatment (Wise 2009). However, despite the gravity of the problem and the authoritativeness of the report, several years passed before selective bans were enforced by the European Union, starting from the mid-1990s (Casewell et al. 2003), and by the USA, only at the beginning of 2017 (Brüssow 2017). As for total bans, Sweden forbade the use of all antibiotics as feed supplements in 1986, while the European Union followed in 2006 (Li 2017). The situation is now so dramatic (Jasovský et al. 2016) that Dame Sally Davies, the chief medical officer for Britain's Department of Health, speaking to members of the parliament, affirmed that resistance to bacteria is a more urgent threat to humanity than global warming (Edwards 2013). Following a research commissioned in 2014 by the UK Government and issued in 2016, every year 700,000 people die because of antimicrobial-resistant infections, and the number could rise up to ten million by 2050 (O'Neill 2016). The WHO has identified six main causes of this tragedy: *"over-prescribing of antibiotics, patients not finishing their treatment, over-use of antibiotics in livestock and fish farming, poor infection control in hospitals and clinics, lack of hygiene and poor sanitation, lack of new antibiotics being developed"* (WHO 2018).

In the meantime, the number of iatrogenic deaths taken as a whole increased in the United States from 98,000 in 1999 to 180,000 in 2010, while a study issued in 2013 estimated the annual number between 210,000 and 440,000 (Carver and Hipskind 2017). Abuse and misuse of self-medication (Sansgiry et al. 2017) as well, enhanced by the wide diffusion of the web (Mehmood et al. 2016), is nowadays an increasing problem, and the simultaneous transfer of power from national governments to pharmaceutical industries is aggravating the situation (De Angelis 2016).

In short, despite the huge successes achieved over the last decades, Western medicine, as is normal for every human realization, is showing many limits. Faced with this, it is not surprising that the WHO has long suggested countermeasures, and it is not difficult to guess that some of these consist in recuperating certain features, typical of traditional medicines, too hastily put aside. From this point of view, it no longer makes sense to view traditional medicine existing in opposition to Western medicine, but as an instrument to improve the efficacy through filling some gaps of the latter.

After decades, or even centuries, in which the *new* was seen as an absolute best, inexorably wiping out the *old*, it is now time to recognize tradition as being able to make, in turn, some improvements to the new. In other words, what has long been considered "outdated," is now providing important innovative elements to what seemed to represent the undisputed figure of the *new*. A striking example of this novel trend is the title given to a book edited in 2009 by Wiley-Blackwell, where measures implemented for centuries in the control of infectious diseases are now presented as novelties.[5] A year later, the International Institute for Environment and Development (IIED) and SOS Sahel International qualified as "modern"some

[5]Ahmad I, Aqil F (eds) (2009) New Strategies Combating Bacterial Infection. Wiley-Blackwell, Weinheim.

traditional systems of mobile husbandry.[6] Not by chance, *"the use of herbal medicines and phytonutrients or nutraceuticals continues to expand rapidly across the world"* (Ekor 2013).

8.5 Practical Inputs Deriving from a Functional Interaction between Traditional and Western Medicine

Starting from the current issue of antimicrobial resistance, phytomedicine can prove very useful. In fact, the problem may be significantly reduced by the use of herbal preparations, as it encompasses several active principles and adjuvants, resulting in a complex interaction of different mechanisms of action (Zorloni 2017). Moreover, because of their quick metabolization, such preparations limit the problem of residues in foodstuffs of animal origin (Eloff and McGaw 2009), reducing or even clearing withdrawal times.

Of course, an industrial purified drug is much more powerful, but in every specific situation, a wise evaluation is necessary to decide strategically which power is required, so as to avoid an unjustified increase in the negative factors often associated with the greater power. In turn, Western medicine, through its very advanced laboratory methods, is functional to explore effects, doses, mechanisms of action, and toxicity of the various traditional preparations. Moreover, traditional medicines, because of their rich variety, are hardly comparable with each other, so modern laboratory techniques can provide the opportunity for efficacy validation, standardization of procedures, and portability of data.

A rather complex field to investigate is the approach to health and the awareness in the use of drugs by people. In all Africa, Western medicine has led to huge health advances. However, being an imported product, it has never been fully integrated into traditional communities and has therefore led to a series of problems that could have been avoided with appropriate work on people's awareness. Ignorance of notions like secondary effects, suspension times, expiry, and storage conditions, has involved a plethora of examples, often with tragic effects, of irrational use of Western medicine. Throughout sub-Saharan Africa, it is very easy to see vendors exposing unidentifiable industrial loose tablets on their stalls in the sun, as well as nurses injecting patients with nonsterile syringes and drugs diluted in common water, disregarding correct diagnosis and proper dosage. The problem also exists in industrialized countries, as evidenced by the abuse of antidepressants and erectile function enhancers, as well as by the irrational use of the Internet as a tool for self-diagnosis and self-medication. Not surprisingly, after being only considered an instrument for studying traditional cultures, anthropology is currently proving an important tool to ameliorate healthcare even in Western countries (Closser and Finley 2016).

[6] De Jode H (2010) Modern and Mobile. The future of livestock production in Africa's drylands. International Institute for Environment and Development (IIED) and SOS Sahel International UK, London.

The recovery of a more balanced "cultural vision" of health, with values and figures of reference well selected by tradition, can certainly benefit both rural and industrialized worlds. In this regard, the use of magic spells during treatments was frequently too hastily qualified as mere superstition by the researchers. On the contrary, as I have personally seen among the Nigerien peuls, and as admitted by many healers themselves, the use of esoteric formulas is often an instrument to avoid superficial and inappropriate use by inexperienced people. In fact, it is not by chance that it is usually reserved for treatments requiring a complex execution and a proven experience to avoid unwanted risks.

8.6 Tradition and Written Documents

The supposed unbreakable link between traditional medicine and orality is another bias that shall be eliminated. Toward the end of his long reign, King Hammurabi of Babylon wrote down, in a well-organized corpus, a collection of rules already enforced in the then Mesopotamia. In article number 224 and 225 of the document, from around 1750 BCE, the figure of the animal healer is explicitly mentioned (Roth 1995). Previously, references of veterinary treatments seem to appear also in some Egyptian papyrus fragments, known as Papyrus of Kahun, roughly one to two centuries before the Hammurabi Code (Walker 1964; Von den Driesch 2001). This topic is clearly discernible in lines 22 and 35, and probably also from 51 to 53 of the Papyrus of Kahun (Leclainche 1955a). Concerning the Hammurabi Code, if we just look at the two articles in question, we might conclude that they merely apply on the payment due by an ox- or donkey-owner to a vet. However, in order to give a major authority to the text, King Hammurabi thoroughly recalls in the prologue his right to reign, received from deities. In the same way, in the epilogue, he stresses on the eventual punishment that gods will reserve for people guilty of infringing the Code. In conceiving the document, the modernity of Hammurabi consisted in using written form to reinforce traditional rules already existing, in order to facilitate their transmission.

One of the most influential medical books ever issued is the *De materia medica*, written in the First Century CE by the Greek physician and apothecary Pedanius Dioscorides, considered the father of pharmacology. The manuscript was translated in Arabic in the Muslim Spain of the tenth century, and in Latin during the Renaissance. Several translations followed in vulgar languages so that the treaty remained in vogue till the nineteenth century. This book, together with the *De simplicium medicamentorum facultatibus libri undecim* written by Claudius Galenus in second–third century CE, has been analyzed by Leonti et al. (2015) to evaluate the possible influences on the current traditional ethnobotany in southern Italy, concluding that *"repeated cumulative transmission of cultural traits through written sources shapes consensus on the use of medicinal plants."* The important role of written documents in the transmission of traditional knowledge has also been documented by Paula De Vos (2010).

8.7 Communication, Research, and Vision Issues

The central function of language in sharing information within the multifaceted parts of the scientific world has been noticed (Ford and Peat 1988), as well as the difficulty of mutual understanding when classical methods are used to evaluate complementary medicine (Hunter and Grant 2005). Obviously, the question becomes considerably more complex when the scientific-academic world has to communicate with a rural environment evolved around criteria usually disregarded by official science. As already mentioned when dealing with spells, this is often the cause of many errors in the evaluation of indigenous knowledge. In fact, *"knowledge or science, and its methods of investigation, cannot be divorced from a people's history, cultural context and worldview"* (Owusu-Ansah and Mji 2013). Some photographs of traditional healers and traditional pharmacy are shown in Fig. 8.1.

The need to set up alternative methods to increase the participation of a community in development issues has been felt for a long time (MacDonald 2012). The debate has undergone rapid improvement in the 1940s, following the publications of the Prussian psychologist Kurt Lewin, credited to have coined the term *research-*

Fig. 8.1. (**a**, **b**) Somali traditional healers in southern Ethiopia; (**c**) traditional drug seller in Ivory Coast; and (**d**) traditional pharmacy in a Sahrawi refugee camp (southern Algeria). (Photographs: A. Zorloni)

action (Adelman 1993). Nowadays, the importance of a participatory approach in health research, aimed to empower beneficiaries, has been widely acknowledged (Baum et al. 2006). Meanwhile, many scales have been developed to evaluate the different levels of participation (Jones and Kardan 2013), among which the classification proposed by Jules Pretty in the mid-1990s (Pretty 1995) is still much applied today.[7] The proposal to develop a participatory research methodology fully adapted to the context of traditional African communities particularly spread since the 1980s, after the publications of the Afro-American philosopher Molefi Kete Asante,[8] the initiator of the concept of *"Afrocentricity as a theory of change* [that] *intends to relocate the African person as subject"* (Mkabela 2005). With the overcoming of the roles of researcher as subject and local people as object of research, there is a clear shift from the classical research methodologies recommending anonymity and impartiality, and considering *"the knower as separate from the known"*; in fact, with the Afrocentric approach, not only *"the researcher empathizes and identifies with the people being studied in order to understand how they see things,"* but he also enter in the research as *"a real historical individual with concrete specific desires and interests"* (Mkabela 2005). To some extent, more than a new approach, it is a question of recognizing a dynamic taking place independently of the chosen methodology. Indeed, due to the great importance given to interpersonal relationships, members of traditional African communities developed considerable empathy and capacities to perceive the expectations of the interlocutor. For instance, face to face with a kind interviewer showing interest for their matters, they feel pushed to give the answers they think may please him more, and this, if a researcher is not aware of it, can constitute a limit to the reliability of the research. In a way, one shall learn to understand even what is not said, besides what is openly stated. A communicative limit I often observed during interviews conducted in African rural contexts is not so much due to linguistic difficulties (quite easily transposed by a prepared translator) as to the dissimilar meanings given to the interview.

A frequent cause of misunderstanding is due to the different importance acknowledged in the various aspects of health issues and medical treatments. To this purpose, it would be a great mistake to draw a shortcut between alleged "irrationality" of traditional cultures and "ineffectiveness" of treatments, concluding that, due to the openness to a world not limited to biochemical mechanisms, the solutions adopted in the medical field by traditional African communities inevitably have a limited effect. On the contrary, by virtue of the empiricism that characterizes a large

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[7] The seven increasing levels of participation identified by the scale proposed by Pretty are: *Manipulative Participation, Passive Participation, Participation by Consultation, Participation for Material Incentives, Functional Participation, Interactive Participation, and Self-Mobilization*.

[8] Asante, MK (1980) Afrocentricity. The theory of social change. Amulefi Publishing Company, Buffalo, New York.

Asante MK (1987) The Afrocentric idea. Temple University Press, Philadelphia, Pennsylvania.

Asante MK (1988) Afrocentricity. Africa World Press, Trenton, New Jersey.

Asante MK (1990). Kemet, Afrocentricity, and Knowledge. Africa World Press, Trenton, New Jersey.

part of the rural world, these solutions must show some effectiveness, even if this does not happen according to the ways we are used to and it does not respect the parameters of classically understood science. In a field of knowledge developed through an empirical observation, certain practices have been selected on the basis of their simple efficacy, without paying attention to logic unrelated to the local vision of life.

Difficulties in matching scientific and traditional knowledge principles in performing a research on health matters have been widely discussed in literature (Durie 2004). In a traditional rural context, notions such as mechanism of action, or cause and effect relationship limited to biology, do not have much meaning. Traditional healers, as well as their patients, are not at all interested in differentiating biological from mechanical effects. During field research on natural acaricides performed in African countries, I often noticed a sensitive discrepancy between effects reported by local people and results issued from laboratory tests. It was not difficult to understand that, in a large number of cases, the effect traditionally recorded is due to the presence of latex in the plants, mainly belonging to the Euphorbiaceae family. Wrapped in such a sticky substance, ticks become incapable of movement and fall from the host. But if manually cleaned out of latex, the same ectoparasites often reacquire normal vitality. In a test performed in a Sahrawi area of southern Algeria, where I was acting as co-promoter of a graduate thesis, I completely plunged ten *Hyalomma dromedarii* ticks in pure *Euphorbia officinarum* latex and other ten in the *Euphorbia balsamifera* one. After 24 hours, the latex solidified, thus preventing the ticks from moving. Once cleaned with extreme care from the latex, 19 of them resumed normal movements and only one showed some slowdown (Lavanga 2012). Obviously, this mechanical effect is not noticeable in laboratory tests, if dried extracts are used. Curiously enough, in such trials, I observed better acaricidal results with plants as *Pergularia tomentosa*, a species containing only a small amount of latex, than with plants like Calotropis procera or *Euphorbia* spp. which are particularly rich in latex and, therefore, more used in tick control by local people. Moreover, species without latex, like Citrullus colocynthis, *Hammada scoparia*, and *Cistanche phelypaea*, are locally used as acaricides after boiling, in order to give them a sticky consistency. Finally, what is the better solution to achieve the goal of tick control in remote areas: using plants containing active compounds with acaricidal properties, but requiring a plodding preparation to exert the effect, or choosing plants with mechanical activity only, but ready-to-use, either directly or after simple boiling in normal water? How not to lean for the latter? Some of the plant species investigated are represented in Fig. 8.2.

Moreover, in a community of gerri (a Somali stock-owner group living in southern Ethiopia), I met beekeepers convinced that the bee queen was actually a male, in fact locally called "bee king". However, this mistake did not affect the excellent skills they had gained over time in beekeeping at all. In the same way, among a Tuareg camel-owner group that I met in Niger, I noticed both a deep knowledge of animal pathologies and big errors in etiopathogenetic interpretation, but the latter usually does not interfere with the cure. For example, in case of pulmonary edema with pleural effusion, local people think that liquids enter the lungs through the

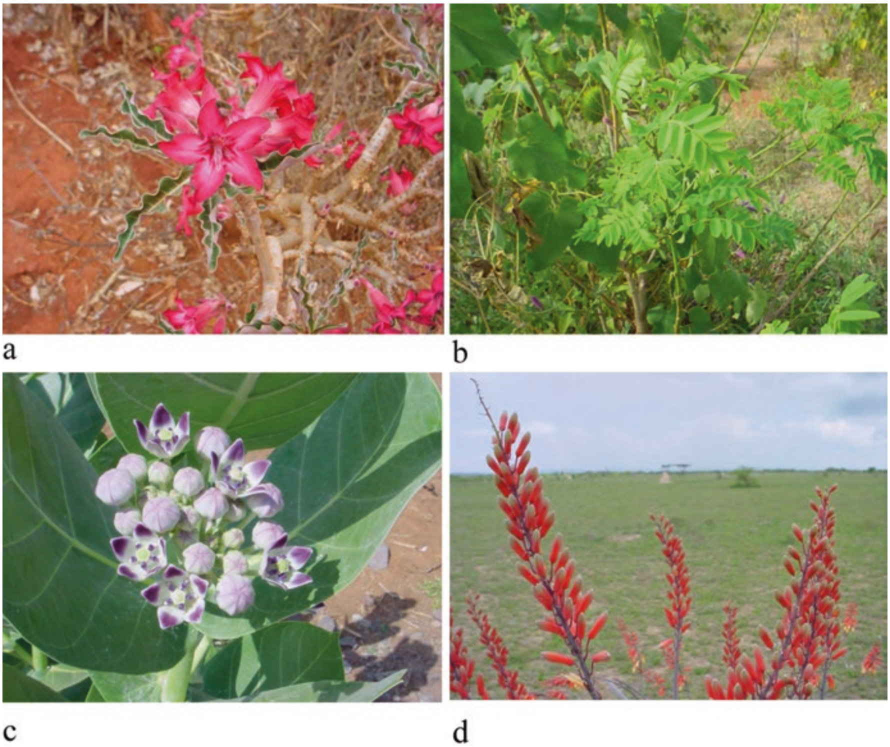

Fig. 8.2 (**a**) *Adenium somalense* (flower); (**b**) *Calpurnia aurea*; (**c**) *Calotropis procera* (flower and leaves); and (**d**) *Aloe calidophila.* (Photographs: A. Zorloni)

lesions found on their surface, and not vice versa; however, such mistake is not decisive in the consequent suitable choice.

Unlike what happens in the industrialized world, in the traditional African communities the various disciplines do not have to respond to scientific principles but have to be inserted into the social, natural, and supernatural apparatus in which the community itself finds its raison d'être. Many features, quite neglected by Western medical science even if they are far from being irrational or ineffective, enter in this vision. We already mentioned that health, as any other important aspect of the living, is never an individual issue in African traditional groups, but always a social matter. This vision fully responds to the principles of *ubuntu*, an isiZulu term derived from the aphorism *Umuntu Ngumuntu Ngabantu* ("A person is a person through the others") (Khomba 2011), related to *"a philosophical concept that frames a particular worldview and in turn structures behavioral expressions of humanity"* (Wilson and Williams 2013). Sometimes, putting at all costs the needs of the community above those of the individual can lead to consequences contrary to the positive characteristics associated with the term *ubuntu*, intended as *"the capacity in an African culture to express compassion, dignity, humanity, reciprocity and mutuality in the interest of building and maintaining communities with* *justice and mutual caring"* (Nhemachena et al. 2018). In fact, in a gueré community of the western part of Ivory Coast, I heard stories about people strongly marginalized, and in some cases even killed, because they had not been willing to share their fortunes with the extended family and to intervene to help members with difficulties. This sort of paradox may be partially understood considering the very harsh selection those communities have evolved through, a situation at the limits of survival that in many cases still remains today. In such a condition, social cohesion has a fundamental importance, much more than the social emergence of individuals that could cause imbalances and therefore a sensitive weakening of the social fabric. For African traditional cultures, the final target is the shared survival, achievable only by respecting rules and reinforcing social ties within the community.

Without considering this vision, it is very hard to understand choices frequently made by rural people living in those areas. In fact, for small stock-owners or husbandmen operating in the Western economic system, the main goal is to maximize profit, as their major risk is to be excluded from the market competition. On the contrary, for small farmers or stock-owners of most of sub-Saharan Africa, the main goal is to maximize security, as the risk is being unable to guarantee survival for themselves and their families.

From that, another important question springs: the temporal-space dimension. Development projects, as well as governmental plans, have a pre-established duration and the results must be documented within a certain time, quite regularly losing a suitable long term perspective. Given the difficult economic situation of many African countries concerning repaying debts and adjusting the balance of payments, programs are usually designed to achieve monetary results in a short time. In this context, lands are seized from people exerting traditional extensive use on a communitarian basis to be transferred to private companies, capable of intensive use. Such a policy, although it may seem economically convenient in the short term, involves two serious counterproductive factors. In the first place, it favors social disintegration of many rural communities, accelerating the already serious phenomena of urbanization and migration, as well as putting young people at risk of being ensnared by criminal or terrorist groups. Secondly, the disappearance of uncultivated lands, suitable for feeding livestock in case of protracted drought, deprives the mobile stock-owners of an important shock absorber, thus increasing their middle and long-term vulnerability.

8.8 Chaotic Urbanization and "Modern" Africa

Till now we have talked about rural Africa, but we have to consider that, in sub-Saharan countries, the percentage of people living in rural areas is decreasing year after year. According to World Bank data, this proportion was 85% in 1960, but in 2017 it had fallen to 61% (World Bank 2018). Although, due to the absence of an official definition applicable to all countries (Dorélien et al. 2013), we can find discrepancies among data issued from different sources, nonetheless in the next decade Africa is expected to show the highest rate of urbanization in the planet (McGranahan and Satterthwaite 2014). On the causes of this trend, there is a plethora of articles in literature, with topics ranging from land grabbing to climate change, and from agro-business to huge differences in services between towns and rural areas. In this regard, the Food and Agriculture Organization (FAO) speaks about *"the multifaceted drivers of rural migration,"* and enumerates as many as 50 causes which can articulate variously among them, giving rise to countless situations (Mercandalli and Losch 2017).

Even if a certain amount of traditional values can be transferred and reproduced in the urban ambit, the environment of towns, especially in poor and overcrowded slums where about ¾ of the sub-Saharan urban population is living (Kajumulo Tibaijuka 2004), is not at all favorable to this relocation. Of course, traditional knowledge has repeatedly demonstrated amazing capacities to adapt and evolve throughout history, but the ongoing urbanization process in Africa is too quick and chaotic to happen profitably. New communities are formed and new reference figures are met in the urban ambit as well, but they are by no means comparable to the traditional ones. In such a situation, an unlucky mix of Western medicine facilities and traditional beliefs gives rise to misguided forms of health practices in which quacks wallow. This state of affairs pushes many African governments to oppose, or at least not to support, traditional medicines in its entirety, because of the difficulty in finding a precise limit between traditional knowledge and fraudulent cunning. Moreover, development projects, because of their need to adhere to strictly precise amounts of funding and execution times, are usually not suited to the complex analysis that traditional medicine would require. In fact, many research studies on the latter have been performed in the last decades in Africa, but in the vast majority of cases the goal was limited to simple data collections, usually made through interviews, while it only rarely reached the stage of concrete programs implementation.

But there is more. African urbanization is not only a process of movement in space but also, and above all, an abandonment of old values to acquire some others. Enucleated from the context of traditional community, the individual, and especially the young person, changes his dreams and aspirations. Urban facilities, technology, and Western habits are not simply seen as tools to be used in a proper way to improve one's own welfare, but as an ideological "modernist" framework to adhere to in an absolute manner, definitely abandoning any old pattern. In the 1980s, my first job in Africa was in the eastern part of the former Zaire, as a teacher in a veterinary institute. After some time I realized that, approaching the end of the studies, the ambition of many students, from an emotional point of view, was not so much to properly treat animals, but to wear a white coat and handle all those beautiful instruments that made them feel, and appear in the eyes of the others, as modern professionals. I well remember their eyes shining when taking a syringe, no matter if using dirty water to dilute drugs for injection.

Moreover, there are not only students but also graduated vets. For many African colleagues, getting a degree has been a dream and an effort far greater than mine, and it has often consumed the savings of the whole family. With constancy and tenacity, they have endured hard years of study away from home, and now they have finally achieved a place in which they can put into practice what they learned at the university. In many occasions I noticed how difficult it is, for many of them, to take a step backward, de-absolutize some notions acquired in the academic premises, and resume listening to those elderly people by now considered belonging to the past.

The problem is also present at veterinary public services level, and an emblematic example concerns a caterpillar provoking camel abortions in Sahelo-Saharian environment. Reported many times by nomadic shepherds, it received little attention by the veterinary services of the concerned countries, mostly convinced that the relationship between the ingestion of the caterpillar and the abortigenic phenomena was casual. In the absence of a scientifically proven pathogenetic mechanism, some papers by researchers (Diagana, 1977; Bizimana 1994; Ould Taleb 1999; Kane et al. 2003; Antoine-Moussiaux et al. 2006; Inci et al. 2014; Traoré et al. 2014) also have long been ignored. Finally, a 2013 report (Volpato et al. 2013) suggested that the mechanism of action in question was the same hypothesized to explain some abortions observed in mares in the USA (Adkins 2005; Neuendorf 2007; McDowell et al. 2010; Tobin and Brewer 2013). However, still in 2017, I found serious difficulties to make the matter accepted by some Sahelian veterinary services.

8.9 Conclusions

In the 1980s, I began my first experience in Africa as a vet. Knowing that I should work in an area with big problems of tick-borne diseases, I studied in detail the different strategies of tick-control, chemicals to be used, dilutions, and timing of treatments. One day, while I was having lunch at my house, somebody knocked at the door. It was a nurse from the local hospital, showing me a small bottle containing a colored liquid. Two young shepherds had just used it to make a shampoo against lice. I knew very well that product, because I had employed it, and even promoted it, many times; however, for the thick hide of cattle it was used at a 1:2000 dilution, while the boys had rubbed it pure on their head! Unfortunately, at the pharmacy of the hospital no oximes were available to counteract the organophosphate effects, and the treatment with atropine did not prove sufficient, so one of the two boys died and the other showed nervous disorders for some time. The event struck me a lot, and I started wondering what I was actually doing. That is how I began to approach ethnoveterinary practices. Some years later, in an animal pharmacy of southern Ethiopia, I saw a Somali nomad purchasing a powerful chemical to treat his camels against ticks. After pouring it into a glass bottle closed at its best with a cork that allowed some leakage, he stored it in his bag with some *chapati* cooked for lunch. Noteworthy is the fact that we were in an arid area, where no particular problems of tick-borne diseases were reported; moreover, I knew that in the local pharmacopeia many acaricidal plants were well known, as I personally evaluated 28 of them in laboratory tests at the Faculty of Veterinary Sciences at the University of Pretoria.

The history of ethnoveterinary medicine is not foreign to me. It is my story. I went through all its phases, from initial lack of consideration, and skepticism, followed by shy interest, to finally engage myself in research and trials. In the last 30 years many things happened. The controversy between skeptics and enthusiasts is now over, a mass of scientific articles has been produced, and research methods more suited to the African context have been developed. But practical applications in formal programs are still lacking. Local names of livestock diseases and plants for treatment, as well as traditional methods of preparations, have been recorded in every corner of the continent. Documents on methodologies to better involve African traditional communities in ethnoveterinary research and extension have been published in large quantities. Feasibility and suitability studies have been elaborated, and laboratory trials have been executed. However, the feeling that the mountain gave birth to a mouse is making its way among the researchers. Studies on indigenous knowledge are nowadays questioned (Sillitoe and Marzano 2009; Sillitoe 2010; Briggs 2013), while supplies of chemicals as well as applications of Western medical systems almost entirely cover both human and animal health programs in Africa. Meanwhile, too many times traditional treatments have been reduced to symbolic examples ideologically contrasting with the "deplorable" *Big Pharma* world. And too many times the valorization of indigenous knowledge and local participation has been limited to a (right) support for traditional communities in a quest for adequate political recognition. From this perspective, it is certainly true that participatory methodologies have an intrinsic value per se. But it is equally true that, given the widespread misery affecting many African communities, it is very important to seek concrete outputs in improving their life conditions.

As already mentioned, the long time required by participatory methodologies and the difficulty of circumscribing ethnoveterinary practices in precise budgetary plans push both NGOs and national ministries to undertake the well-schematizable channels of Western systems. But we the researchers also have some degree of guilt. Even endeavoring to carry out experimentation in a scientifically correct manner (Cos et al. 2006), and leaving aside the numerous examples of unreliability (Ramey 2007), we have too long been content to collect data and perform laboratory tests, trusting that others (who?) will then translate our research into practical programs. It is now time to conceive research directly in the field, focusing on the immediate testing of traditional practices applied by stock owners and traditional healers. In other words, the meeting point between Western medical science and traditional African medicine must be moved from the laboratory to the field, not staying limited to interviews but directly focusing on practical applications, to fully achieve the mutual benefits of the two systems. Some decades ago, practice allowed researchers to overcome the controversy between sceptics and enthusiasts. Now, we shall resort to it again to fill the gap between research and field applications. Trying to reproduce practice in the laboratory, so as to define the various parameters with more precision, is of little use if it is an end in itself. Limiting to that means further widening the gap between research and practical applications. Laboratory tests shall not be abandoned, but must be aimed to provide a better analysis of reality, not to replace it. And the reality is enormously more complex compared to what can be studied in detail with a test. Just to bring an example limited to botanical aspects, we know that it is very hard (not to say rather impossible) to reproduce the effects of a plant extract by isolating its various components, since these always work through a complex synergistic action. And beyond the botanical focus, we also have social, economic, and other aspects to be taken into account. Therefore, we need now to define parameters directly of the current practice, although we have, in this way, to deal with a much larger series of variables and we can in no way seek the precision of laboratory tests. But one wonders: what is the purpose of precision if it takes us too far from the actual field situation? Obviously, it is a challenging path, because moving away from precision may enhance the risk of inaccuracy, therefore facilitating misleading conclusions, and even hype. In my opinion, the impasse can be solved by widening the range of attention, so as to carry out research that embraces different aspects of the issue: medical, botanical, ecological, social, economic, and others, with the aim of identifying a viable strategy, effective and preferable to others, to be put into practice and monitored.

We have done a little bit, may young researchers start from here.

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Part III
Ethnoveterinary Medicine Around the World

Chapter 9
Ethnoveterinary Medicine and Medicinal Plants Used in the Treatment of Livestock Diseases in Cameroon

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Keywords Ethnoveterinary medicine · Animal disease · Medicinal plants · Cameroon

9.1 Introduction

The use of natural products to treat diseases is not only restricted to humans but extends to treat various disorders in animal species as well. In Cameroon, veterinary public health is not integrated into the mainstream of public health services. There are no formal mechanisms within government public health services through which veterinary skills and resources can be effectively harnessed to bear upon community health (Awa et al. 2003). There is no conscious, overt or substantial effort by public authorities to incorporate veterinary public health services in the overall approach to public health. Veterinary public health activities cover mainly the control of the major animal diseases transmissible to man (zoonoses) (Belino 1992). Therefore, animal health care is a major challenge. As result, the use of medicinal plants as a source of drugs in treating animal diseases has become a traditional practice. A large proportion of the population of animal owners throughout the country relies on traditional healthcare practices to keep their animals healthy and to treat them when they are sick (Toyang et al. 1995). The application of traditional medicine to veteri-

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nary medicine has been termed ethnoveterinary medicine (EVM) which is mainly concerned with folk beliefs, knowledge, skills, methods and practices which are used in the healthcare of animals. It comprises traditional surgical techniques, traditional immunization, magico-religious practices and the use of herbal medicines to treat livestock diseases (Muhammad et al. 2005). Ethnoveterinary practices were introduced in Cameroon at the end of the last century by nomadic Fulani ethnic group pastoralists from neighbouring Nigeria and Chad in search of new pastures (Nfil et al. 1999). The Fulani make up the bulk of the pastoralists and have a long history of the use of traditional medicines (Toyang et al. 1995). All the indigenous knowledge regarding livestock in Cameroon is found among the Fulani. They have knowledge of the epidemiology and the gross pathology of the diseases and ailments that affect their livestock, especially cattle (Nwude and Ibrahim 1980). Before the introduction of orthodox veterinary medicine in Cameroon, pastoralists depended solely on indigenous health practices. Nomadic livestock owners treated animal health problems using various biologicals from plants and animals, while carefully avoiding disease-infested areas and regions dominated by toxic plants. Their knowledge of ethnoveterinary medicine encompassed surgery, pharmacology and toxicology (Nfil et al. 1999). This practice has attracted considerable interest recently in various parts of the world as attested by a plethora of ethnoveterinary surveys conducted in the area.

Given the importance of EVM to low-income populations, particularly in African countries, recording, documenting and disseminating the use of plant species for animal disorders is of great importance in this area. One of the most distinguishing features of Cameroon is its biodiversity. In fact, Cameroon is the most biologically rich country known to date on the African continent (Sunderland et al. 2003). It encompasses an intricate mosaic of diverse habitats with moist tropical forest dominating the south and south-east and covering 54% of the country, mountain forest and savannah in the highlands and sub-Sahelian savannah and near desert in the far north. These diverse habitats harbour more than 9000 species of plants, 160 species of which are endemic (Sunderland et al. 2003). Moreover, a diversity of lifestyles, religions, values and practices can be found in Cameroon. As in most cultures, Cameroonian disease concepts apply more or less equally to animals and people. Healers of people often treat livestock and they frequently employ the same herbs, compounds, manipulative techniques or magical procedures (McCorkle and Mathias-Mundy 1992). Application of medicinal plants as a source of drugs in treating human and animal diseases has been a traditional practice. Ethnoveterinary medicine has become an elemental factor of primary health care, especially for marginalized and poor communities living in remote rural areas (Nfi et al. 2001). Ethnoveterinary medicine often offers less expensive options than conventional medicines, products are locally available and more easily accessible, and are generally less toxic. However, knowledge of ethnoveterinary practices is declining due to inadequate documentation and verbal passage of plant heritage verbally. Documenting indigenous knowledge is important for the conservation and use of biological resources (Yogeswari et al. 2017). Despite the increasing use of ethnoveterinary medicine in Cameroon, this rich indigenous knowledge is not adequately documented. Therefore, the aim of this review is to summarize information on ethnoveterinary medicine practices and medicinal plants used in the treatment of livestock diseases in Cameroon.

9.2 State of the Art of Ethnoveterinary Medicine in Cameroon

Livestock production in Cameroon is carried out mainly by Fulani herd pastoralists who have a long history of the use of traditional medicines (Nfi et al. 2001). According to Toyang et al. (2007), many people depend on their livestock: the animals provide them with food, clothing, labour, fertilizers and cash, and act as a store of wealth and a medium of exchange. These animals are a vital part of culture and in many societies are regarded as equal to humans. Ethnoveterinary knowledge (EVK) continues to be recognized at a global level as a resource that reflects people's total commitment and experience in life (Wanzala et al. 2005), from origin through evolutionary stages to current situation. They accumulate the current rich and resourceful traditional knowledge that has been passed on from generation to generation through word of mouth, traditional songs, poems, drawings, paintings, stories, visions and initiation ceremonies (Wanzala et al. 2005). This knowledge is solely dependent on the collective memory of just a few entrusted persons within communities for it is not just common 'knowledge' for everybody. It is also believed to be collectively and communally owned by ancestors and kept under the custody of living old men and women, depending on the community, ethnicity, sex, age, etc. There is a danger however that this method of vesting knowledge in human custodians can be undermined by mortality, thereby losing important information to the future generations (Wanzala et al. 2005).

The importance of traditional systems of medicine was emphasized by the 30th World Health Assembly in 1977. The Assembly adopted a resolution urging interested governments to give adequate importance to the utilization of their traditional systems of medicine (Nfi et al. 2001). Cultural and religious perception of health is the basis upon which ethnoveterinary practices are applied, like the case of natural products (medicinal plants and by-products); appeals to spiritual forces (rituals, incarnations and prayers) and manipulation and surgery in traditional African healing practices.

In veterinary medicine, attention has turned from orthodox to ethnoveterinary medicine for the following reasons: availability, lower cost, efficacy, one treatment for various ailments, the fact that they rely on local knowledge and manpower, based on materials and equipment which are locally available, part of one's own traditional culture, easy to prepare and administer and much less prone to drug resistance (Nfi et al. 2001; Souto et al. 2012; Toyang et al. 2007).

9.3 Common Animal Diseases in Cameroon and Diagnosis

9.3.1 Diseases

Today, animal diseases remain one of the limiting factors of livestock development in sub-Saharan Africa because they lead to heavy direct and indirect losses in national herds (Sidibe 2001). These diseases sometimes destroy the efforts of the breeders for the multiplication of the herd. The main pathologies encountered in Cameroonian livestock are presented below. Dominant pathologies within the workforce can be grouped into two categories according to the type of pathogen responsible: parasitic diseases and infectious diseases. In these two groups of diseases, we are particularly interested in those that have a great impact on livestock and that therefore constitute real obstacles to the development of livestock in Cameroon.

9.3.1.1 Main Animal Parasitic Diseases in Cameroon

Trypanosomosis is the major parasitic pathology of the Cameroonian cattle herd. It constitutes a major impediment to the rearing of ruminants in the southern part of the country, which presents favourable conditions for the development of tsetse flies, but nevertheless offers strong fodder potential. The direct effects of the disease are mainly the death of the animals which results in a reduction of the livestock of between 30% and 50% and a reduction in the production of meat and milk of at least 50% (Pangui 2001). Considerable losses of animals due to trypanosomosis have been recorded in the Adamaoua Plateau (Saleu 1988). The indirect effects are represented by a reduction of approximately 40% of the land treated by animal traction and a reduction of about 5% to 10% of the total value of agricultural production (Pangui 2001). Other parasitic diseases affect livestock. These are mainly tick-borne diseases (cowdriosis, babesiosis, rickettsioses, anaplasmosis and dermatophilosis), scabies, helminthoses and coccidiosis that cause heavy losses in poultry farms (Ndjana 2006). These parasitic diseases are sometimes potentiated in the same animals by infectious diseases.

9.3.1.2 Major Animal Infectious Diseases in Cameroon

The major infectious diseases that plague Cameroonian livestock vary according to the animal species. In the cattle herd, these diseases are mainly represented by contagious bovine pleuropneumonia (CBPP), foot-and-mouth disease, anthrax and symptomatic coagulants, as well as tuberculosis. On the other hand, Cameroon is provisionally declared free from rinderpest (Ndjana 2006).

Contagious Bovine Pleuropneumonia (CBPP)

Several outbreaks of the disease have been reported in the different cattle breeding areas, particularly in the northern part of the country. To reduce the incidence of CBPP, the state organizes annual vaccination programmes through health mandates in infected areas.

Foot-and-Mouth Disease (FMD)

This disease affects the cattle population of the Western Province. It is also prevalent in the northern part of the country but to a lesser extent.

Anthrax and Symptomatic Coal

These two diseases are particularly prevalent in northern Cameroon, where vaccination campaigns are organized every year to reduce their incidence. The vaccines used are produced by the National Veterinary Laboratory (LANAVET) of BOKLE-GAROUA.

Tuberculosis

Tuberculosis causes significant economic losses in the cattle herd. It is responsible for numerous seizures at slaughterhouses with a capture rate of up to 33.09% (Saleu 1988). The PACE Cameroon component, whose Memorandum of Understanding was signed in December 2001 for an amount of approximately 2.7 million euros, or approximately 1.8 billion CFA francs, has created an epidemiological surveillance network to control the birth of new foci and the evolution of these diseases over the area (Ndjana 2006). Sheep and goat herds, meanwhile, face the plague of small ruminants or Peste des petits ruminants.

Pig farming is confronted with African swine fever which causes significant losses in the industry and in all regions of the country. It limits the exploitation of large numbers of livestock. To cope with this 'weapon of mass destruction' of the Cameroonian pig herd, several measures have been taken by the State. For example, Order No. 000009 of 08/07/82 declaring infection of African swine fever in certain areas of the country remains in force. This decree prohibits the movement of pigs, their products (carcasses, manure, etc.) and breeding equipment, including vehicles used to transport animals and their products, from infected areas to uninjured areas (Ndjana 2006). A programme to support the fight against swine fever has been set up by the Ministry of Livestock, and to this is added the pork project, a project of the Heavily Indebted Poor Countries (HIPC) initiative whose main objective is to find control strategies for African swine fever in Cameroon.

Newcastle and Gumboro diseases are the dominant avian infectious diseases. Mortality rates in endemic cases reach 60 to 80% of the total or 100% (EVALI 1996). A study conducted by Ichakou (2004) showed a prevalence of 63.63% of Newcastle disease in the province of the Far North. Marek's disease, infectious bronchitis and avian cholera also cause heavy losses in local poultry (Kouaghu 2006). In addition to these diseases, bird flu is now the biggest threat to public health and local poultry farming. Indeed, outbreaks of this disease in Nigeria and Niger, Burkina Faso, Egypt and Cameroon place these countries in what De-Deken (2006) called 'the new axis of evil'. In Cameroon, bird flu has been detected in ducks in the Far North Province. An emergency plan has been drawn up by the authorities in charge of breeding to limit its extension.

In summary, the animal health situation in Cameroon remains worrying. Indeed, despite the efforts made by the State to reduce the incidence of major diseases in livestock through regular awareness and vaccination campaigns, animal diseases continue to place livestock farmers in a very uncomfortable economic and social situation. This is also the case in most countries in sub-Saharan Africa where animal diseases still represent the major constraint to livestock development. Far from being overcome by this situation, breeders resort to several methods of fighting against these animal diseases, the most common today being the use of veterinary drugs, hence the purpose of the following chapter which deals with the veterinary drug market in sub-Saharan Africa. This chapter will allow us to see, before addressing in the results the veterinary drugs market in Cameroon, what is the situation in the other countries of sub-Saharan Africa.

9.3.2 Diagnosis

In Cameroon in general and especially amongst the Fulani ethnic group, animal disease diagnosis is performed using the senses: taste, touch, smell and sight as well as supernatural methods like consulting spirits, oracles or divination. Special animals can sometimes be used for diagnosing disease. The following are methods used to diagnose animals (Dharani et al. 2015; Toyang et al. 2007).

General signs of a healthy animal include the following: smooth, shiny skin, moderate breathing (not too fast, slow or loud), cold, moist muzzle and nostrils, bright, clear eyes, warm ears and feet, good appetite, good mobility, no limping or stiffness, for animals that ruminate, cud chewing when resting, normal colour, consistency and amount of faeces and urine, regular reproductive heat periods in mature, non-pregnant females, normal production and colour of milk.

General signs of an unhealthy animal include the following: dull, rough skin, standing hair; persistent coughing, rapid, heavy and noisy breathing; dry muzzle and nostrils; high or low body temperature; lack of appetite; reluctance to move, lameness, stiffness; no response to sounds; hiccupping and shivering; over-excitement; bad smell, change in colour or consistency of faeces or urine, blood in faeces or urine; low milk yield and abnormal colour or thickening of milk.

9.4 Ethnoveterinary Practice in Cameroon

9.4.1 Components of Ethnoveterinary Practices

Ethnoveterinary medicine has been developed by farmers in fields and barns. Ethnoveterinary practices in Cameroon are influenced by cultures and traditions which are not the same throughout the country. The northern part of Cameroon has different practices, structuration, people's behaviour and environment composition than the southern part of Cameroon (Moritz et al. 2013). The north of Cameroon, especially the region of North and Far North has a semi-arid climate with two seasons: short rainy and long dry (Moritz et al. 2013). In contrast, the south of Cameroon has a long rainy season and a short dry season (Ntonifor et al. 2013). The distribution of season influences the behaviour of people and the composition and distribution of plants in these two geographical areas. From these differences, definition of components of the ethnoveterinary practices in Cameroon can include endogenous knowledge, pharmacopeia, pasture management, management of animal houses and animal nutrition, beliefs, control and prevention of diseases and human resources (Ngom et al. 2017; Nfi et al. 2001; Moritz et al. 2013, McCorkle 1986).

Endogenous knowledge is the base of ethnoveterinary medicine in Cameroon. The main description of ethnoveterinary knowledge has been provided by Toyang et al. in 1995 (Toyang et al. 1995). In general, the Fulani tribe comprises the majority of people in Cameroon where endogenous knowledge has been more described, based on their pastoral habits and their long history of plant utilization for animal welfare (Nfi et al. 2001). Endogenous knowledge is a combination of knowledge of the disease that affects the animal, the knowledge of seasonal variation in disease occurrence and different information about plant extracts and pastures to use (Ngom et al. 2017; Nfi et al. 2001; Djoueche et al. 2011). Knowledge is transmitted from one generation to another and it is believed and proved through continual use. Endogenous knowledge is kept by living older people and the transmission is secret. In Fulani tribes, men are in charge of tradition and ancestral knowledge (Moritz et al. 2013; Wanzala et al. 2005). The application of ethnoveterinary medicine is not limited to the curacy of diseases. Plants are used also to prevent appearance of disease and to control it. In the Fulani tribe, prevention is achieved through the respect of rites and observation of taboos. The advanced knowledge of the Fulani in immunity has been used to prevent appearance of diseases in healthy animals. When an animal is infected, for example, by foot and mouth disease, a sample is taken from the lesion of the infected animal and is mixed with salt to serve as vaccine. This mixture is given to a healthy animal by oral administration to create a small infection which will lead to the acquisition of immunity against the disease. The exposition of the healthy animal to the infection is done depending on the time of the year. Usually, exposition is avoided around the end of the dry season. Prevention of diseases is also done mechanically. Daily, farmers remove ticks from their animals. They prevent their animals from being bitten by mosquitoes and flies by utilization of smoky fires (Nfi et al. 2001; Moritz et al. 2013). Ethnoveterinary medicine includes the management of animal housing, their nutrition and their protection in adaptation to local conditions. When the local environment is not adapted to the animals, it will affect their health and influence the behaviour of farmers. Nutrition and water consumed are a source of diseases for this reason, and a closed relationship between farmers and their environment is important. These farmers need to know different compositions of the environment in term of plants, flies, wild animals and accessibility to water of good quality, availability of herbs and pastures. For the management of all of this, initiated people are required at every level of the work. The initiation usually involves men in Cameroon although there are some exceptions (Moritz et al. 2013; Nfi et al. 2001; Wanzala et al. 2005).

9.4.2 Herbal Preparations for Animal Use in Cameroon

Herbs are the most commonly used ingredients in the preparation of ethnoveterinary medicines. It is also important to know which plant to use to treat a particular condition, as wrong identification and use may lead to harmful effects and even animal death (Dharani et al. 2015). All parts of the plants (leaves, bark, fruits, flowers and seeds) are used in medicinal preparations (Toyang et al. 2007). Ethnoveterinary medicinal plants should be collected at the right time and in the right way. Generally, the best times to harvest are during the beginning or end of the dry season because the weather is favourable and most plants start to blossom.

General guidelines for collecting plant material include the following:

- The harvest of leaves and stems is usually best done under dry conditions (warm sunny morning), otherwise material may become mouldy during storage.
- Flowers are best collected just when the buds are opening.
- Underground roots, bulbs, stolons, rhizomes, tubers, etc., should be collected before flowering.
- Fruit should be collected when ripe, unless noted as required otherwise. Seeds should be harvested when fruits are fully ripe, but before shedding.
- Bark collection from trees should generally be carried out from trunks and thick branches, not from small, tender branches. When removing bark, only a portion of the circumference of the trunk should be taken; if the entire circumference is taken this may kill the tree (Dharani et al.,2015; Toyang et al. 2007).

The most common forms of ethnoveterinary preparations are listed below.

Powder Plant parts (bark, roots and leaves) or entire plants are dried then pounded until they form a powder. If desired, the powder is sieved to make it finer. The powder is then given to sick animals directly, mixed in salt or used in the preparation of decoctions and poultices.

Poultice Hot water mixed with powder form makes a poultice or a paste. The paste is then applied on the affected area. Poultices are used on inflamed areas, bruises or to soothe irritations, as well as to withdraw pus, toxins and particles imbedded in the skin.

Ointment and Cream These are made by mixing finely powdered plant material or extracts with butter or cooking oil. The ointment is then applied to affected areas such as rashes or sprains.

Decoction Plant material is chopped into small pieces and added to water. The water is boiled for 15–30 minutes. Only clay or steel pots are used.

Infusion (Animal Tea) Boiling water is poured into a container in which powder or chopped plant parts have been put. The container is covered for 10–20 minutes until the medicinal components are extracted. The water is filtered and given to the animal, cooled or warm.

Cold Water Extract Heat destroys active ingredients so cold water extracts can be made by soaking leaves and roots (cut in small pieces and pounded) overnight in water. The extract should be prepared fresh daily.

Tincture Mixing water (70–80%), alcohol (20–30%) and plant material makes a tincture. The mixture is then kept for some days and used internally or externally.

Fumigation Dry or wet plant material is put in the fire and smoke engulfs the animal. Fumigants are commonly used against ectoparasites such as tsetse flies.

9.4.3 Preservatives

The utilization of ethnoveterinary plants is not always done directly. After preparation of the plant extract, it will be kept for a long time. To preserve all its properties and to be good for utilization even after a period of conservation, extracts are processed by different traditional techniques which are transformation into powders, decoctions, infusions, tinctures, fumigation agents, poultices or pastes or extractions prepared in cold water. These techniques require the action of preservatives for the stabilization of their state. Preservatives are then used to protect the ethnoveterinary extracts from transformation or deterioration (Dharani et al. 2015; Toyang et al. 2007). In Cameroon, many products are used by farmers in ethnoveterinary areas as preservatives. According to their nature, the following can be used:

- Vegetal preservatives (onion, garlic, oil, ginger, etc.),
- Mineral preservatives (salt),
- Transformed and other preservatives (honey, wax, vegetal oil, butter, fat, etc.).

Vegetables in general are used in extracts generally for oral administration. They have high antioxidant capacity to protect both the extract from deterioration and the animal organism from oxidation. Among vegetal preservatives, some of them will be presented. Onion is an important and old ingredient used in food preservation. In ethnoveterinary use, onion has been shown to have bioactive compounds such as sulphuric and flavonoid compounds, which have antimicrobial and anti-oxidant capacity. The utilization of this ingredient will help in the preservation of ethnoveterinary extracts for long periods without transformation of its properties. Salt has always been used as a preservative compound around the world. In Cameroon, it is used in ethnoveterinary medicine as an important preservative and also a complement for animal food. The action of salt in plant extracts is to prevent spoilage and to render the medium inhospitable for pathogens. As we know, water content promotes development of micro-organisms, so the other action of salt is to reduce the water content of extracts and food by the association of its sodium and chloride ions with molecules of water. Vegetable oils are used as preservatives due to their antimicrobial activities. Fulani tribes use them in mixtures with extracts during treatment of wounds and external injury of animals. Vegetable oils have high non-toxicity and no irritance capacity which promotes the ability to be used as a preservative in extracts for external and internal use. Honey is used in combination with fresh extracts, decoctions and powdered extracts. The antimicrobial, antifungal and anti-oxidant capacity of ginger confers on it the potential to be used as a preservative for long periods. Wax and fat are also used as preservatives in ethnoveterinary medicine for better fumigation (Toyang et al. 1995; Bahmani and Zohri 2013).

9.4.4 Traditional Ways of Measuring

The Fulani traditionally learned to diagnose and treat clinical features of endemic animal diseases by the use of traditional equipment like bamboo syringes, stone tourniquets, animal horn products, squashing with their hands, calabash dishes and spoons, bottles, kettles, pans, clay pots, hand palms and finger pinches (Toyang et al. 2007). Wood forceps were also used to determine dosage to prepare remedies from local medicinal plants (Yigezu et al. 2014).

The Fulani sorted out plants they could eat and those they could not, and gradually discovered certain qualities beyond mere edibility such as pain-killing, soothing, relief of fevers, clothing, beddings, building materials, source of firewood, woodcarving, writing materials, worshipping shrines, fences and many other traditional health practices useful to them (Wanzala et al. 2005). The discovery of all these uses of plants must have occurred in a number of ways, not only by the principle of trial and error. Some of these ways include: watching animals treat themselves by eating and rubbing themselves with special plants when ill (zoopharmacognosy) and subsequent adoption of the same remedies, communicating and interacting with the visiting traditional medical specialists from other communities and borrowing their traditional remedial ideas, inheriting the healing powers and magic from parents, buying the healing and magic powers from experienced traditional medical specialists and deliberate experimentation to help select those remedies that work (Wanzala et al. 2005). A significant amount of knowledge regarding which plant or traditional remedy works or not, has also been acquired through observation, 'visions' and during ritual communal gatherings.

Some examples of traditional ways of measuring and applying remedies:

- *Nasal and Eye Drops*: Liquid medicines can be applied to eyes or nostrils with a dropper, straw or folded leaf.
- *Poultices*: A paste is made by grinding seed, fruit, leaves and/or roots, etc., and adding a small quantity of water. The paste is applied to the skin and sometimes covered by bandages or strips of banana leaf. Applications may be renewed at regular intervals.
- *Compress*: A piece of cloth impregnated with medicine is pressed to the skin. The cloth may contain a warm stone for 'warm' treatments.
- *Powder*: An animal may be dusted with a powdered medicine. Lotions and ointments – lotions and ointments may be massaged into the skin. Ointments are traditionally prepared by mixing plant materials with animal fat.

To protect against infection, the administrator should wear plastic gloves or put clean plastic bags over their hands, having first washed their hands and clipped their nails (hands should also be washed after administration). Powdered medicine made into a small ball is carefully pushed into the animal's anus. If the ball is dry, it may be dipped in water or oil to ease entry (Dharani et al. 2015).

9.4.5 Methods for Administering Ethnoveterinary Medicines

Modes of administration of ethnoveterinary drugs involve predominantly the oral route, followed by the topical and then the nasal route (Yigezu et al. 2014). Dermal application of cultural remedies sometimes surpasses oral administration, but the route of application varies widely and is dependent on the desired action and the afflicted organ. Both oral and topical routes are chosen as the best routes of animal drug administration because they permit rapid physiological reaction with the pathogens and increase the curative power of the medicines.

Plant medicines are administered orally by drenching or through salt or mineral licks (Yirga et al. 2012; Toyang et al. 2007). Drenching is the oral administration of ethnoveterinary drugs in a liquid form. After measuring the liquid, it is given to the animals using bottles, kettles or calabash spoons. This is easily done by raising the animal's mouth upwards and inserting the bottle or spoon sideways into the mouth and inserting two fingers on the other side of the mouth to press the tongue downwards, helping to hold the mouth open. The liquid is poured gently at intervals, without removing the drenching instrument, giving the animal enough time to swallow. Ethnoveterinary powders are usually administered in the form of salt and mineral licks (Dharani et al. 2015). The medicines are mixed with salt or minerals, sand and cement in different proportions depending on the formula of the lick stone. Animals ingest the medicines by licking the lick stone. The third mode of oral administration can be achieved by adding medicines to the feed and water of sick animals that are kept isolated from other animals while they eat and drink. To ensure the full dose is taken, medicine may be mixed with or sprinkled on an initial portion of feed that is offered to the animal, which is then followed by the remainder of the feed. Similarly, liquid medicines may be mixed with an initial quantity of drinking water.

Another widely practiced mode of application of ethnoveterinary remedies is in the form of topical application whereby the drug in the form of a paste or powder is used to treat skin lesions and eye diseases. A paste is made by grinding the ingredients to a powder and adding a small amount of water. A powdered remedy can be applied directly to the affected area, for example, to treat wounds or eye problems. Poultices or pastes are made by grinding seeds, fruit, leaves and/or roots, etc., and adding a small quantity of water. The paste is applied to the skin and sometimes covered by bandages or strips of banana leaf. Applications may be renewed at regular intervals. A compress can also be used which is a piece of cloth impregnated with medicine which is then pressed to the skin. The cloth may contain a warm stone for 'warm' treatments. Lotions and ointments may be massaged into the skin. Ointments are traditionally prepared by mixing plant materials with animal fat. However, vegetable oils, Vaseline and Lanoline may also be used.

Skin application can also be achieved through bathing the animals with liquid medicines, either their whole bodies or just the affected areas. Washing the animal with a decoction, an infusion or another non-plant mixture is a common and widely used ethnoveterinary method. It is used in the treatment of ectoparasites such as lice, and some infectious diseases such as heartwater (cowdriosis) and haemorrhagic septicaemia (Nfil et al. 1999).

Other methods of external application of ethnoveterinary drugs involve fumigation and spraying**.** Fumigation is a practice in which dry powders or dry coarse materials are burnt in clay pots or on the ground so that the smoke engulfs the sick animal or the entire herd. Organisms on the animal, such as flies, mosquitoes and ticks, are killed by the poisonous gas or smoke. Spraying is not a very common practice in ethnoveterinary medicine but it is sometimes applied by experienced ethnoveterinary practitioners whereby animals are sprayed with liquid medicines.

Invasive modes of application involve the anal and vaginal application. In these methods, the administrator wears plastic gloves or puts clean plastic bags over their hands to protect against infection, after having first washed their hands and clipped their nails (hands should also be washed after administration). Powdered medicine made into a small ball is carefully pushed into the animal's anus or vagina. If the ball is dry, it may be dipped in water or oil to ease entry. Today, young ethnoveterinary practitioners sometimes use needleless syringes to introduce liquid medicines into the anus. For the vagina application, the animal's birth opening (vulva) is washed with soap and warm water. Taking the medicine in one hand and, cupping this hand into a cone shape, it is pushed gently into the vagina, leaving it in deep inside the vagina and slowly withdrawing the hand.

9.4.6 Storage Methods and Storage Locations

9.4.6.1 Storage Methods

After harvesting, medicinal plant parts need to be handled appropriately. Some parts may need to be used immediately, while others can be stored and their activity retained. Clearly, storage is carried out in such a way that the chemical compounds needed for therapeutic activity are maintained as effectively as possible. The container used for storage – calabashes, clay pots, plastic tins and bottles, animal horns, animal skins, pans, polyethylene and paper bags, etc. – will depend on the background and resources of the particular traditional healer or farmer.

Two important ways of preserving ethnoveterinary medicines are storing them in a dry form or in a liquid form as a decoction. If all the necessary steps have been taken for harvesting and processing, and the medicines are stored in the right way, dry medicines will remain active for several years. Liquid forms do not last for such a long time, although tinctures can be stored for at least 6 months.

In the dry storage method, medicinal plant materials are stored after drying and may remain active for several years. Air-drying in partial shade is preferred compared to drying under full sun, over a fire or in an oven, as too much heat may destroy active compounds. Adequately dried plant material can be stored in clean, closed containers, either in pieces (e.g. bark) or after grinding into a powder (leaves, bark, etc.). Containers should be labelled with their content and kept in a cool, dry place.

Plants may also be stored fresh by mixing with honey after which they may be stored in a clean container for some time while retaining activity. In the liquid storage method, decoctions (water extracts) are preserved for a few months; tinctures (alcoholic extracts) typically last for at least 6 months. The boiling of water extracts supports their preservation, but it is only appropriate if the active compounds are not destroyed by heat. Clean, sterilized (by boiling water) containers with good covers support preservation. Preservatives such as castor oil or limestone can be useful.

9.4.6.2 Storage Locations

Ethnoveterinary medicines are preferably stored in dry locations. They are not kept on the ground but suspended inside the house, away from other people. Clay pots are suspended by using a rope or they may be placed above the ground on a three-stone stand. Preservatives are used to store ethnoveterinary medicines for longer periods. Some preservatives have their own medicinal properties. Preservatives most commonly used in ethnoveterinary medicine include:

Alligator Pepper

Alligator pepper (*Aframomum melegueta*) can activate ethnoveterinary medicines and also act as a preservative.

Butter Oil

Before powders are put in the storage containers, they can be thoroughly mixed with some melted butter. The butter should just be enough to wet the powder without forming a paste. In general, one part butter should be mixed with ten parts powder by weight.

Fat from Cattle

Powder from ethnoveterinary plants can be preserved by mixing it with fat. Fat also helps plants to burn well for fumigation.

Ginger

Materials mixed with ginger can be stored longer.

Honey

Honey acts as a major medicinal component and preservative in fresh residues, decoctions and powders.

Limestone

Added to mixtures or decoctions, limestone helps to break down plant and other ethnoveterinary materials to release the active ingredients, making the medicinal drug more effective.

Vegetable Oils and Butters

Vegetable oils and butters can be added to a powder or decoction and then boiled with limestone. The limestone helps to mix the fat with the liquid.

Wax from the Danniella Oliveri Plant

The wax of this plant is burnt together with the medicinal powder in a container.

9.5 Plant Species Commonly Used in Ethnoveterinary Practices in Cameroon

The major animal diseases treated with plants include both metabolic diseases (such as constipation, infertility and liver problems) and infectious diseases (including gastrointestinal diseases, salmonellosis and disease due to ectoparasites). Gastrointestinal diseases and diseases caused by ectoparasites are mostly present in cattle and are therefore usually managed by farmers (Table 9.1).

For the treatment of these diseases, local people mainly use traditional medicines made from medicinal plants. In this work, we recorded 138 plants belonging to 69 families and 110 genera that are used in Cameroon to manage livestock diseases (Table 9.1). The most represented family of plants is Fabaceae (9.48%) followed by Euphorbiaceae (5.83%), Rubiaceae (5.69%), Liliaceae (4.37%), Combretaceae (4.37%) and Solanaceae (3.64%). The other families had a frequency of representation of less than 3%. Leaves were the most used part (33.5%), followed by bark (18.7%) and roots (16.77%). Nevertheless, fruits (7.74%), seeds (5.16%), branches (3.22%), stems (3.87%), whole plants (3.22%), bulbs (2.58%), gum resin (1.93%), pods (0.66%), shoots and flowers were also used. The various methods of preparation and administration of the medicinal preparations used by the local population are also presented in this table and it appears that the majority of the remedies are taken orally (63.8%) although topical administration (30%), administration by inhalation (3.07%) and ocular administrations (3.07%) are also practiced. Drenching is cited as the method of oral administration most used by breeders. These different routes of administration are used to administer the remedies generally obtained by maceration (38%), decoction (32%) and perfusion (6%). In addition, preparations for topical uses such as ointments are also used (24%).

Regarding the dosage of the remedies and the duration of the treatment, it appears that the quantities of remedies administered to young animals vary from a teaspoon to 0.5 L with 0.5 L the most commonly administered volume. For adult animals, the quantities range from 0.5 L to unlimited quantities with unlimited quantities being the most used by the population. These doses of remedies are administered one to several times a day with a duration of treatment ranging from 2 days to an indeterminate date, which generally corresponds to the date of healing of the animal. It also appears that 3 days of treatment is generally used by the population as the appropriate treatment time for animals.

In the preparation of traditional remedies, the use of additives is often practiced. These additives included water (68.9%) present in almost all medicinal preparations, salt (12.4%), limestone (5.4%), ghee (1.5%), fresh milk (1.5%), cereal bran (1.5%), urine (0.77%), paraffin oil (0.77%), horse bones (0.77%), kitchen ashes (0.77%) and soap (0.77%).

It also appears from this table that some plants are not used alone in the preparation of traditional remedies but in combination with other plants. For example, *Tagetes minuta*, prepared in association with *Capsicum frutescens,* is used for the treatment of ringworm, ticks and ectoparasites.

Table 9.1 Medicinal plants traditionally used for management of animal diseases in Cameroon

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Acacia nilotica (Mimosoideae)	Nile- thorn (Mgunga)	Fresh pods are crushed, macerated into water and then used to wash the affected areas.	Topical	Contagious pustular dermatitis, contagious ecthyma (Dharani et al. 2015)
Acacia oerfota (Mimosoideae)	Green-barked acacia (Ol-depe)	Maceration is prepared from fresh bark and used to drench the cattle (2 L/dose). Infusion is prepared from fresh bark coming from roots using water for 30 min and then used to drench the sick animal (once a day for 2 or 3 days)	Topical, oral	Diarrhoea and anaplasmosis (Dharani et al. 2015)
Acacia refciens (Fabaceae)	*Acacias*	Fresh roots and bark are crushed and macerate into water and used to drench the camels (3 L/dose)	Oral	Trypanosomosis/trypanosomiasis (sleeping sickness, Surra) (Dharani et al. 2015)
Acacia seyal (Mimosaceae)	White galled acacia, white whistling thorn (Badehi)	Dry bark is grounded, mixed with the fruits and rock salt, and then given to cattle (in any quantity until cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Adansonia digitata (Malvaceae)	African baobab	The fruits and leaves are cut into pieces, crushed and mixed with saltlick and then given to the animal.	Oral	East Coast fever (Dharani et al. 2015)
Adenium obesum (Apocynaceae)	Desert rose (Mwandiga)	Maceration is prepared from crushed plant (whole plant) using water and then use to wash the affected cattle. The maceration is prepared from the fresh leaves and used to wash the affected cattle.	Topical	Ectoparasites (fleas), ticks (Toyang et al. 2007; Dharani et al. 2015)
Ajuga remota (Labiatae)	Ajuga (Osogonoi)	Decoction is prepared from fresh leaves and the liquid obtained is used to wash the animal.	Topical	Ectoparasites (ticks) (Dharani et al. 2015)

Albizia anthelmintica (Mimosaceae)	White albizia (Olmugutan)	Maceration is prepared from crush barks using water for 6 h and then used to drench the cattle	Oral	Lungworms (ascaris worms) (Dharani et al. 2015)
Allium sativum (Liliaceae)	Garlic (Kitunguu sum)	The bulbs are crushed, mixed with water and the liquid is used to wash the animal (once a day until it is free of lice)	Topical	Ectoparasites (lice) (Dharani et al. 2015)
Allophylus macrobotryls Gilg. (Sapindaceae)	(Surma)	Leaves and stems are crushed with barley, squeezed, water is added and then given to cattle (0.5 L/dose)	Oral	Fracture (Yigezu et al. 2014)
Aloe barbadensis (Liliaceae)	Aloe (Njaboa)	The sap of the leaves is applied on the wound.	Topical	Wounds (physical injuries like accidents, bites from other animals or wounds inflicted by man) (Toyang et al. 2007)
Aloe bartesi (Liliaceae)	Zabuwa)	/	Oral	Helminthosis (Nfi et al. 2001)
Aloe marlothii (Asphodelaceae)	Mountain aloe (Tshikhopha)	Juice is squeezed from the ground leaves and then given to the animal	Oral	Liver problems in chickens/ Newcastle disease (Luseba and Tshisikhawe 2013)
Aloe secundiflora (Liliaceae)	Aloe. (Esuguroi, Mshubiri)	Leaves are crushed and macerated into water. The liquid obtained is then used to rub or brush onto the parts of the animal's body where ticks are present. Leaves are pounded, mixed with paraffin oil and kitchen ash to make a paste. The paste is then applied onto the parts of the animal's body with ticks. The leaves are crushed, mixed with water and then brushed on to infested parts of the animal's body. The juice of the leaf is applied on the wound (one teaspoon/dose)	Topical	Mites, ectoparasites (ticks), wound healing after castration (Toyang et al. 2007; Dharani et al. 2015)

Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Annona senegalensis (Annonaceae)	(Dukuhi, Bududi)	/	Oral	Diarrhoea and antiseptic (wounds), helminthosis, tuberculosis (Toyang et al. 1995; Nfi et al. 2001)
Anogeissus leiocarpus (Combretaceae)	Chewstick tree (*Godoli,* Marke)	Decoction is prepared from bark using water, and then given to cattle (in any quantity until cured).	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats), helminthosis (Nfi et al. 2001; Djoueche et al. 2011)
Arachis hypogea (Fabaceae)	Peanut (Biriji)	Maceration is prepared from grinded raw nuts using fresh milk and then used to drench the animal (any quantity, once a day for 3 to 5 days)	Oral	Infertility in cows (infected uterus, aberration of libido, vulva has two small openings which blocks penetration of penis) (Toyang et al. 2007)
Asparagus falcatus L (Asparagaceae)	Sickle thorn (Lufhaladzamakole)	The whole plant including roots are immersed for 24 h in water and then given to the animal (1 L once a day for 3 days)	Oral	Constipation in cattle (Luseba and Tshisikhawe 2013)
Asparagus officinalis (Liliaceae)	Sparrow grass (Nyaryarngel)	/		Black quarter (Nfi et al. 2001)
Azadirachta indica A. Juss (Meliaceae)	Neem tree (Dogonyaro)	Seeds of the plant are pounded until they turned brown and sticky, water is added and the mixture is squeezed to remove the oil. The oil is rubbed on the animals to repel flies and other biting insects. The seeds are pounded, cooked and water is mixed to make a paste. The paste is squeezed to extract oil and the oil is then used to rub the animal	Topical	Ectoparasites (Toyang et al. 2007; Dharani et al. 2015)
Bombax costatum Pellegr. & Vuillet. (Bombacaceae)	Red-flowered silk cotton tree (*Bouboli*)	Decoction is prepared from barks using water, and then given to cattle (in any quantity until cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)

Bridelia ferruginea (Euphorbiaceae)	(Buduudi)	Decoction is prepared from grinded barks using water, and then given to cattle. Decoction is prepared from the barks using water in which one handful of limestone was introduced, and then use to drench the cattle (0.5 L twice a day for 1 week)	Oral	Snakebite, brucellosis, bloody diarrhoea, fertility enhancement, gastrointestinal diseases (internal worms and parasites in cows, sheep and goats), ringworm (Toyang et al. 1995, 2007; Djoueche et al. 2011)
Cacia dolichocephala (Fabaceae)	Toppa-akasia	Maceration is prepared from fresh bark using water and then used to drench cattle (1 L of the liquid for cattle, 0.5 l for goats and sheep)	Topical	Babesiosis (Redwater fever) (Dharani et al. 2015)
Calotropis procera (Asclepiadaceae)	(*Baladi*)	Fresh roots are ground, rock salt is added, and then given to cattle (in any quantity until cured).	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Calpurnia aurea (Fabaceae)	Calpurnia (Digita)	Fresh leaves are made to paste by adding little water and then rubbed to cattle	Topical	Ectoparasites (Yigezu et al. 2014)
Calypha fruticose (Euphorbiaceae)	Birch leaved *acalypha*	Dry leaves are pounded, mixed with butterfat or ghee to form a paste and then applied once to affected areas.	Topical	Pox (Dharani et al. 2015)
Capsicum frutescens (Solanaceae)	Hot pepper (Bupilipili)	Seeds are crushed, mixed with water and then given to the birds for 3 days	Oral	Newcastle disease (fowl pest) (Dharani et al. 2015)
Carica papaya (*Caricaceae*)	Pawpaw, papaya (Gondahi)	Maceration is prepared from leaves using water and then used to drench the animal (1 L per animal in the morning and in the evening)	Oral	Retained afterbirth (Toyang et al. 2007)
Carissa bispinosa subsp. *Bispinosa* (Apocynaceae)	Num-num (Tshirungulu)	Bulbs are ground, mixed with water and then given to the cow (1 L per cow)	Oral	Calving difficulties in cattle (Luseba and Tshisikhawe 2013)
Carissa edulis (Apocynaceae)	Natal plum (Mtandamboo)	Fresh fruits are ground, cereal bran is added and then given to cattle (in any quantity for 2 days: Morning, noon and evening)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)

(continued)

Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Cassia kirkii (Leguminosae)	(Sura) (Colombi)		Topical	Bloat (Nfi et al. 2001)
Cassia occidentalis (Caesalpinaceae)	(Tapasa)	/	Topical	Worms, blackquarter, anaplasmosis and babesiosis (Toyang et al. 1995)
Ceiba pentandra (Malvaceae)	Kapok tree	/	Topical	Dermatoses (Konsala et al. 2013)
Cephalanthus natalensis Oliv. (Rubiaceae)	Strawberry bush (Murondo)	Leaves are ground and then given to the animal (1 L bottle per animal)	Oral	Eye problem in cattle (Luseba and Tshisikhawe 2013)
Citrus aurantifolia (Christm.) (Rutaceae)	Lime (Lomi)	Fruit is squeezed and then given to hens until recovery (1/2 cup/dose)	Oral	Poultry disease (Yigezu et al. 2014)
Cola acuminata (Seruliaceae)	Cola nut (Gorohi)	/	Oral	Babesiosis (Toyang et al. 1995)
Combretum glutinosum Perr. (Combretaceae)	(*Dooki*)	Branches are burned and smoke is inhaled by the cattle (in any quantity until cured).	Inhalation	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Commiphora africana (Burseraceae)	Poison-grub commiphora (Osilalei)	Decoction is prepared from bark and the liquid obtained is used to wash the animal	Topical	Ectoparasites (ticks) (Dharani et al. 2015)
Commiphora erythraea (Burseraceae)	Commiphora (Hagar-medow)	The gum resin of the plant is mixed with camel urine and the mixture then is applied onto the parts of the animal's body with ticks. The gum resin of the plant is mixed with camel urine. The mixture is heated, stirred to make a paste which is then applied on the infected skin. Maceration is prepared from crushed fruit with water and used to wash the animal. The gum resin of the plant is mixed with water and then used to make a paste which is applied on the infected skin	Topical	Ringworm, mites and ectoparasites (ticks) (Dharani et al. 2015)

Commiphora myrrha (Burseraceae)	Gum myrrh tree (Malmal)	The gum resin of the plant is mixed with water and heated and stirred until the gum dissolves. The preparation obtained is applied warm to tick wounds	Topical	Ectoparasites (ticks) (Dharani et al. 2015)
Crinum glaucum (Amaryllidaceae)	(Gaadal)	Maceration is prepared from pounded whole plant using water and then used to drench the animal (2 L to adult cattle for 3 days)	Oral	Snakebite (Toyang et al. 2007)
Croton macrostachyus (Euphorbiaceae)	Broad-leaved *croton* (Bakkannisa, Ngalawahi)	Leaves are pounded and squeezed with water, and then applied on the cattle. Leaves are crushed and rubbed on infected lesions and then applied topically to cure ringworm	Topical	Ringworm, bloat, lesion and purgative (Toyang et al. 1995; Tekle 2014; Yigezu et al. 2014; Birhanu and Abera 2015)
Croton megalocarpus (Euphorbiaceae)	Silvery-leaved croton(Olmergoit)	Decoction is prepared from fresh bark using water and used to drench the sick animal. Maceration is prepared from fresh young leaves for 3–5 min and used to drench the cattle (any quantity for up to 3 days)	Topical Oral	Anaplasmosis (Dharani et al. 2015). Salmonellosis (fowl typhoid, pullorum disease) (Dharani et al. 2015)
Cucurbita maxima (Cucurbitaceae)	Pumpkin	Decoction is prepared from fresh leaves using water for 45 min and then used to drench the cattle (twice in 1 day and repeat after 1 month)	Oral	Stomach and intestinal worms (Dharani et al. 2015)
Cussonia barteri (Araliaceae)	Bolo Koro		Oral, topical	Diarrhea, dermatoses (Konsala et al. 2013)
Daniella oliveri (Caesalpiniaceae)	African copaiba balsam, west African copal, Ilorin balsam, wood-oil tree (*Karlahi*)	Dry roots are ground, cereal bran is added and then given to cattle (in any quantity for 2 days: Morning, noon and evening)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Detarium macrocarpum (Caesalpiniaceae)		Decoction is prepared from barks using water, and then given to cattle (in any quantity until cured).	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Dichrostachys cinera (Mimosaceae)	(Burli)		Oral	Brucellosis and bloody diarrhea (Toyang et al. 1995)

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Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Diospyros lycioides subsp. lyciodes (Ebenaceae)	Karoo bluebush (Muthala)	Leaves are ground, mixed with water and then applied on the affected area of the animal.	Topical	Ticks in cattle (Luseba and Tshisikhawe 2013)
Diospyros mespiliformis (Ebenaceae)	African ebony (Kany)	/	Oral	Helminthosis (Nfi et al. 2001)
Dissotis perkinsiae (Melastomaceae)	(Bodehon)	Decoction is prepared from the roots using water and then used to drench the animal (0.25–0.5 L per calf once).	Oral	Diarrhoea (Toyang et al. 2007)
Dodonaea angustifolia (Sapindaceae)	Sand olive (Ittacha)	Leaves are pounded and mixed with salt and then given to cattle. Fresh leaves are crushed, water is added and then given to livestock for 1–2 days (2 cups/dose)	Oral	Bloat, liver disease, diarrhea (Yigezu et al. 2014)
Echinops kebericho (Asteraceae)	(Kebercho)	Roots are powdered, mixed with water and then given to cattle and sheep.	Oral	Skin infection (Yigezu et al. 2014)
Ehretia rigida (Boraginaceae)	Puzzle bush (Mutepe)	Decoction is prepared from the roots and then given to the cow (1 L to cows and 0.5 L to young animals)	Oral	Eating problems in cattle (Luseba and Tshisikhawe 2013)
Elaeodendron transvaalensis (Celastraceae)	Bushveld saffron (Mulumanama)	Fruits are ground, mixed with water and then given to the animals (1 L to cows and 0.5 L to young animals)	Oral	Worms in cattle (Luseba and Tshisikhawe 2013)
Elephantorrhiza burkei (Fabaceae)	Sumach bean (Gumululo)	Bulbs are ground, mixed with water and then given to the animal	Oral	Diarrhoea in cattle (Luseba and Tshisikhawe 2013)
Ensete ventricosum (Musaceae)	Red banana (Qocho)	Extract of the stem is applied on mouth of cattle. Stem is crushed and mixed with salt and then given to cow	Topical, oral	Retained placenta, foot and mouth disease (Yigezu et al. 2014)

Entada africana Mimosaceae)	(Fadowandoki, Peluwaahi)	Maceration is prepared from barks for 1 day using water, and then given to cattle (in any quantity until cured)	Oral	Gastrointestinal, helminthosis, ephemeral fever, babesiosis, foot and mouth disease (FMD), babesiosis and worms (Toyang et al. 1995; Nfi et al. 2001; Djoueche et al. 2011)
Erythrian senegalensis (Papilionaceae)	(Bobillohi)	/	Oral	Ringworm, mange and brucellosis (Toyang et al. 1995)
Fagaropsis angoleusis (Rutaceae)	(Siglu)	Fresh leaves are crushed, mixed with water and salt, and then given to cattle (0.5 L/ dose).	Oral	Liver fluke and fattening of cattle (Yigezu et al. 2014)
Ficus elastica (Moraceae)	Rubber plant (Biskehi)	/	Oral	Fertility enhancements (hormone) (Toyang et al. 1995)
Garcinia livingstonei (Clusiaceae)	Lowveld mangosteen (Mupimbi)	Juice is squeezed from the fresh leaves and then introduced into the eye of the animal.	Ophthalmic	Eye problems in cattle (Luseba and Tshisikhawe 2013)
Gardenia ternifolia (Rubiaceae)	Yellow Gardenia (dii-ngali)	Maceration is prepared from roots for 1 day using water, and then given to cattle (0.25 L of the solution every day until it is cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats, aphrodisiac and growth-enhance (Toyang et al. 1995; Djoueche et al. 2011)
Gladiolus dalenii (Iridaceae)	Wild gladiolus (Phende-phende)	Juice of the ground bulbs is squeezed and then applied on the infected eye	Ophthalmic	Eye problems in goats, sheep and cattle (Luseba and Tshisikhawe 2013)
Grewia similis (Tiliaceae)		Decoction is prepared from crushed roots using water and then use to drench the cattle (0.5 L per cattle)	Oral	Diarrhoea (Dharani et al. 2015)
Guiera senegalensis (Combretaceae)	Moshi medicin e (*Gelohi*)	Branches are burned and smoke is inhaled by the cattle (in any quantity until cured)	Inhalation	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)

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Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Harrisonia abyssinica (Rutaceae)	Harrisonia (Mkidori)	Decoction is prepared from crushed fresh roots using water for 10 min and then used to drench the cattle (1 L per cattle, once daily for 2 day)	Oral	Contagious pleuropneumonia (bovine and caprine) (Dharani et al. 2015)
Harungana madagascariensis (Clusiaceae)		Maceration is prepared from fresh leaves using water, and then given to cattle (in any quantity until cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Hibiscus esculentus (Malvaceae)	Okra (Kubeje)	Maceration is prepared from pounded dry fruits using water and then used to drench the animal (2 L per animal)	Oral	Retained afterbirth (Toyang et al. 2007)
Hymenocardia acida (Euphorbiaceae)	French digbé	/	Oral	Diarrhea (Konsala et al. 2013)
Hypoestes aristata (Acanthaceae)	Ribbon bush	Infusion is prepared from the whole plant and then used to drench calves	Oral	White scours (Dold and Cocks 2001)
Justicia schimperiana (Acanthaceae)	(Sensel)	Maceration is prepared from crushed leaves using water, and then given to cattle (2 cups/dose)	Oral	Black leg (Yigezu et al. 2014)
Kalanchoe crenata (Crassulaceae)	Noppi Bali	/	Topical	Worms, blackquarter, anaplasmosis and babesiosis (Toyang et al. 1995)
Khaya anthotheca (Meliaceae)	East African mahogany (Kahi)	Decoction is prepared from fresh roots using water, oil, limestone and then used to drench the cattle (0.25 l (half dose) and 0.5 l (full dose)-were administered per calf for each treatment group once every morning for two consecutive days). Decoction is prepared from the bark using water for 30 min and then used to drench the animal (2 L/dose)	Oral, topical	Bloat (tympany), blackquarter, brucellosis, diarrhoea, worms and babesiosis, helminthosis (Toyang et al. 1995; Nfil et al. 1999; Toyang et al. 2007)

Khaya senegalensis (Meliaceae)	Khaya wood, Senegal mahogany, cailcedrat, (*Dalehi*)	Decoction is prepared from roots using water, then given to cattle (in any quantity three times per days: Morning, noon and evening)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Kigelia africana (*Bignoniaceae*)	Sausage tree (Jillahi)	Dry fruits are ground, powder of horse bones and salt are added and the mixture is then given to the animal (in any quantity once a day for 1 month). Dry fruits are grinded, mixed with horse bone, salt and then presented as a supplement to the infected every day for 1 month	Oral	Brucellosis, retained placenta and mastitis (Toyang et al. 1995; Toyang et al. 2007; Dharani et al. 2015)
Lantana trifolia (Verbenaceae)	Lavender popcorn (Saamba)	Maceration is prepared from crushed leaves using water and then use to drench the animal (0.25 to 0.5 L per calf). Fruits are ground and macerated into water. The liquid obtained is then used to drench the cattle (1 L per cattle)	Oral	Lungworms (ascaris worms) (Toyang et al. 2007; Dharani et al. 2015)
Maerua angolensis (Capparaceae)	Bead-bean tree (Mutambanamme)	Maceration is prepared from the ground leaves using water and then given to the cow (1 L to cows and 0.5 L to young animals)	Oral	Eating problem drought (Luseba and Tshisikhawe 2013)
Maesa lanceolata (Myrsinaceae)	(Abayi)	Leaves and seeds are pulverized, mixed with salt and water and then used to drench the animal (1 L/dose)	Oral	Internal parasite (Yigezu et al. 2014)
Maytenus senegalensis (Celastraceae)	African mahogany (Tultulk, Yengotehi)	Decoction is prepared from the leaves using water, and then given to cattle (in any quantity until cured).	Oral, topical	Black quarter, gastrointestinal diseases (Nfi et al. 2001; Djoueche et al. 2011)
Mitragyna inermis (Rubiaceae)	(Kadioli)	Infusion is prepared from crushed roots using warm water and then given to cattle (in any quantity three times per days: Morning, noon and evening until cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)

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Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Momordica foetida (Cucurbitaceae)	(Minaan)	Maceration is prepared from pounded roots and leaves using water, and then given to donkey (2 cups/dose)	Oral	Abdominal colic (Yigezu et al. 2014)
Mucuna pruriens (Fabaceae)	Elvet bean (Kararawol)		Topical	Dermatitis, lumpy skin (Nfi et al. 2001)
Myrsine Africana (Primulaceae)	Myrsine (Enkoduai)	Maceration is prepared from crushed leaves using water, then use to drench the animal (0.25 to 0.5 L per calf)	Oral	Intestinal worms especially tapeworms (Toyang et al. 2007)
Nicotiana tabacum (Solanaceae)	Tobacco plant (Tambo)	Dried leaves are soaked overnight with water, squeezed and then given to cattle (1 cup/dose). Leaves are crushed, soaked in water overnight, and then given to cattle and sheep. Decoction is prepared from the leaves using water, soap is added and then the mixture is used to spray the affected animal	Nasal, oral and nasal, topical	Blackleg, snakebite, for fattening of cattle and ticks (Toyang et al. 2007; Yigezu et al. 2014; Dharani et al. 2015)
Ochna holstii (Ochnaceae)	Red ironwood (Tshipfure)	Shoots are mixed with water and then given to the animal.	Oral	Not eating in cattle (Luseba and Tshisikhawe 2013)
Ocimum lamiifolium (Lamiaceae)	(Damakase)	Maceration is prepared from pounded roots and leaves using water, and then given to the donkey (2 cups/dose)	Oral	Abdominal colic (Yigezu et al. 2014)
Olea capensis subsp. *macrocarpa* (Oleaceae)	Black ironwood (Woira)	Leaves are chewed and then applied to eye (1 teaspoon/dose)	Topical	Eye infection (Yigezu et al. 2014)

Parkia biglobosa (Mimosaceae)	African locust bean tree (Narehi)	Infusion is prepared from crushed roots using water, and then given to cattle (in any quantity until cured). The burned ground sheep skin is mixed with the powder of the plant, salt and milk are added and then applied on the cow (mother) head, neck and back	Oral, topical	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats), poor mothering (Toyang et al. 2007; Djoueche et al. 2011)
Pennisetum glaucum (Poaceae)	Pearl millet (Yadiiri)	/		Brucellosis (Nfi et al. 2001)
Phytolacca dodecandra (Phytolaccaceae)	African soapberry (Endod)	Roots are washed, pounded; water is added and then given to equine. Infusion is prepared from the roots and then used to drench calves	Nasal, oral	Lung sickness in cattle, equine disease (Watt and Breyer-Brandwijk 1962; Yigezu et al. 2014)
Piliostagma thonningii (Fabaceae)	Camel's foot tree (Barkeh)	/	Oral	Ringworm (Nfi et al. 2001)
Piliostigma reticulatum (Caesalpiniaceae)	Camel's foot (Barkeleh)	Maceration is prepared from bark for 1 day using water, then given to cattle (in any quantity until cured).	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Piliostigma thonningii (Fabaceae)	Camel foot (Barkehi)	Juice obtained from pounded fresh fibrous bark is applied directly to the infected eye (daily for 3–7 days)	Ophthalmic	Eyeworms (thelaziosis) (Toyang et al. 2007; Dharani et al. 2015)
Prunus africana (Rosaceae)	Red stinkwood (Olkoijuk)	Maceration is prepared from powdered bark using water and then used to drench cattle (once a day for 2 days)	Oral	Babesiosis (Redwater fever) (Dharani et al. 2015)
Pseudolachnostylis maprouneifoloia (Euphorbiaceae)	Kudu berry (Mutondowe)	Maceration is prepared from ground bark using water and then given to the cattle (1 L to cows and 0.5 L to young animals)	Oral	Drought tonic (Luseba and Tshisikhawe 2013)
Psidium guajava (Myrtaceae)	Guava (Ngoyabehi)	/	Oral	Diarrhoea, blood tonic (Nfi et al. 2001)

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Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Psorospermum febrifugum (Hypericaceae)	(Sawoiki)	Dry bark is powered, mixed with butter and then the ointment is applied on the affected area until the wound heals	Topical	Wounds (physical injuries like accidents, bites from other animals or wounds inflicted by man) (Toyang et al. 2007)
Psorospermum guanensis (Clusiaceae)	(Sawoiki)	/	Topical	Tick infestation (Nfi et al. 2001)
Pygeum africana (Rosaceae)	*African* plum, *African* prune	/	Topical	Anaplasmosis (Nfi et al. 2001)
Ricinus communis (Euphorbiaceae)	(Qobo, kolakolahi bloat)	External part of the seed is removed, ground very well, mixed with water and then used to drench the equine. Dry seeds are powdered, boiled to make oil and the oil is then applied on the wound (completely covering the wound until it heals)	Oral, topical	Respiratory manifestations, wounds, purge, oil used in drug preservation and administration, antidote to poisoning in animals and humans (Yigezu et al. 2014; Dharani et al. 2015)
Rothmania capensis (Rubiaceae)	Wild gardenia (Murathamapfene)	Decoction is prepared from roots using water and then given to the animal (2 L bottle per animal)	Oral	Eating problem in cattle (Luseba and Tshisikhawe 2013)
Rumex nervosus (Polygonaceae)	Oseille Sango	Roots are dried, chopped and crushed into powder and then given to the cattle.	Oral	Internal parasite (Gebrezgabiher et al. 2013)
Saba comorensis (Apocynaceae)	Rubber vine		Oral	Diarrhea, dermatoses (Konsala et al. 2013)
Salix subserrata (Salicaceae)	Keelehi	Dry leaves are powdered, mixed with salt and then used to feed the sterile animals (once a day for 1 week	Oral	Infertility in bulls (brucellosis) (Toyang et al. 2007)

Salvadora persica (*Salvadoraceae*)	Mustard tree (Mswaki)	Decoction is prepared from the roots using water and then used to drench the animal (2 L per cow drench once). Maceration is prepared from crushed roots using water for 12 hours and then used to drench the animal (1 L per animal for 1 to 2 days)	Oral, topical	Mites, brucellosis (retained afterbirth (Toyang et al. 2007, Dharani et al. 2015)
Sarcocephaelus latifolus (Rubiaceae)	African peach	/	Oral	Diarrhea (Konsala et al. 2013)
Securidaca longepedunculata (Polygalaceae)	(Alali)	Decoction is prepared from the roots using water, and then given to cattle (in any quantity until cured).	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Senna didymobotrya (Fabaceae)	(Sanaamaki)	Fresh leaves and young stems are grinded, mixed with water, drenched and then applied topically for external parasite.	Oral, topical	Snakebite, ectoparasites (Yigezu et al. 2014)
Senna petersiana (Fabaceae)	Monkey pod (Munembenembe)	Maceration is prepared from the leaves and then given to the goat (0.5 L per goat)	Oral	General illnesses in goats (Luseba and Tshisikhawe 2013)
Solanum aculeastrum. (Solanaceae)	Goat apple, bitter apple, poison apple (Gitte- nai)	The affected area of the animal is scrubbed with the inside of the fruit (for 1–3 days)	Topical	Streptotricosis and worms (Toyang et al. 1995; Toyang et al. 2007)
Solanum incanum (Solanaceae)	Sodom apple (Endulelei)	Decoction is prepared from fruits mixed with limestone using water and then used to drench the cattle	Oral	Liver fluke disease (fasciolosis) (Dharani et al. 2015)
Strychnos henningsi (Logoniaceae)	Red bitter berry	Decoction is prepared from fresh bark using water for 20 min and then given to the cattle (0.2 L to cattle twice a day for 3 days)	Oral	East Coast fever (Dharani et al. 2015)
Synadenium cupulare (Euphorbiaceae)	Dead-man's tree (Muswoswo)	Latex is applied on the side of the eyelid after applying pig or cattle fat	Ophthalmic	Eye problems (infections) (Luseba and Tshisikhawe 2013)
Tagetes minuta (Compositae)	Khaki weed; Mexican marigold	Fresh leaves are used to rub the body of the animal. The juice of the stems, leaves and flowers is collected after crushing and then used to rub affected areas (once a day for 3 days). Leaves are mixed with *Capsicum frutescence*, ground and then the mixture is applied the on the ticks	Topical	Ringworm, ticks and ectoparasites (lice) (Luseba and Tshisikhawe 2013; Dharani et al. 2015)

(continued)

Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Tephrosia nana (Fabaceae)	Hoarypea (Yomji wild)	/	Topical	Mange and ticks (Toyang et al. 1995)
Tephrosia vogelii (Fabaceae)	Vogel's tephrosia (Yomji)	Leaves are pounded. Wood ashes are soaked in water, stirred thoroughly, filtered and mixed with the pounded leaves. The mixture is filtered and then 1 L of cow urine is added. Animals are sprayed with the solution	Topical	Lice, mange, ticks and balckquarter (Toyang et al. 1995; Nfi et al. 2001; Toyang et al. 2007; Dharani et al. 2015)
Terminalia collinum (Combretaceae)	Combretum, the bushwillows (Koulahi)	Branches or leaves are burned and smoke is inhaled by the cattle (in any quantity until cured)	Inhalation	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Terminalia glaucescens (Combretaceae)	Bawshihi	Decoction is prepared from crushed fresh barks using water, limestone for 10 min and then use to drench the cattle (0.5 L per cattle, once daily for 3 day)	Oral	Helminthosis (Nfil et al. 1999; Nfi et al. 2001)
Terminalia laxiflora (Combretaceae)	Brown's myrobalan, Amargna, Abalo, Weyeba, Gamogna	Decoction is prepared from the bark using water, and then given to cattle (in any quantity until cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Trema orientalis (Ulmaceae)	Pigeonwood (Mukurukuru)	Maceration is prepared from ground leaves, mixed with water and then given to the animals	Oral	Gallsicknes (Luseba and Tshisikhawe 2013)
Trianthema portulacastrum (Aizoaceae)	Black pigweed, carpet weed, giant pigweed	Dry leaves are grounded and then given to cattle (in any quantity until cured)	Inhalation	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Turrae obtusifolia (Meliaceae)	(Mbhovane)	Leaves are crushed and directly applied on the wound	Topical	Wounds in goats, sheep and cattle (Luseba and Tshisikhawe 2013)

Urelytrum digitatum (Poaceae)	(Nikiti)	Decoction is prepared from the roots using water containing limestone and then used to drench the animal (0.5 L per calf a day, for 3–5 days)	Oral	Stomach and intestinal worms (Toyang et al. 2007)
Verbascum sinaiticum (Scrophulariaceae)	Mullein (Suffi)	Fresh leaves are pounded, mixed with water, then squeezed and given to cattle (0.5 L/dose)	Oral	Skin infection (Yigezu et al. 2014)
Vernonia amygdalina (Asteraceae)	Ebicha, Suwak	Leaves are mixed with salt and then given to cows. Leaves are pounded, macerated in water, filtered, burned limestone powder is added and then given to the animal.	Oral	Retained placenta (Yigezu et al. 2014). Stomach and intestinal Worms (Toyang et al. 2007). Worms, diarrhoea and purgative (Toyang et al. 1995)
Vernonia corymbosa (Asteraceae)	(Phathaphathane)	Roots are ground, mixed with water and then given to the cattle (1 L to cattle and 0.5 L to young calves	Oral	Worms in cattle (Luseba and Tshisikhawe 2013)
Vernonia guineense (Asteraceae)	Guinea	/	Oral	Diarrhea (Konsala et al. 2013)
Vitellaria paradoxa (Sapotaceae)	Shea butter (*Kareji*)	Maceration is prepared from bark of this plant with those of *Bombax costatum* for 1 day using water, and then given to cattle (in any quantity until cured)	Oral	Gastrointestinal diseases (internal worms and parasites in cows, sheep and goats) (Djoueche et al. 2011)
Vitex doniana (Verbenaceae)	Black plum, Meru oak(Bummehi)	Decoction is prepared from the barks using water containing limestone and then used to drench the animal (6 L per animal at once)	Oral	Brucellosis, shipping fever and anaplasmosis/babesiosis, retained afterbirth (Toyang et al. 1995, Toyang et al. 2007)
Warburgia ugandensis (Rutaceae)	East African greenheart (Olsokonoi)	Maceration is prepared from fresh bark and then used to drench the cattle (0.3 L per day for 2–3 days). Decoction is prepared from roots and bark and then used to drench the animal (0.3 L per day for cattle and 75 mL per day for sheep). Decoction is prepared from stem bark using water and then used to drench the animal (0.5 L per animal)	Oral	Trypanosomosis/trypanosomiasis (sleeping sickness, Surra) and East Coast fever (Dharani et al. 2015)

(continued)

Table 9.1 (continued)

Scientific name (Family)	Common (English) name (Local or vernacular name)	Parts used and methods of preparations (Dosage)	Route of administration	Disease condition
Withania somnifera (Solanaceae)	Ashwagandha (Gizawa)	Fresh leaves are crushed, squeezed and then given orally (2 teaspoons/dose); some leaves are smoked by placing on fire	Oral, inhalation	Evil eye (Yigezu et al. 2014)
Xanthocersis zambesiaca (Fabaceae)	Nyala tree (Mushato)	Maceration is prepared from ground bark using water, mixed with salt and then given to the cattle (2 L per animal)	Oral	Diarrhoea in cattle (Luseba and Tshisikhawe 2013)
Ximenia americana var. *microphylla* (Olacaceae)	Blue sourplum (Muthanzwa)	Decoction is prepared from leaves and branches using water and then given to the animal (1 L once a day for 3 days)	Oral	Wounds in goats, sheep and cattle (Luseba and Tshisikhawe 2013)
Zanthoxylum chalybeum (Rutaceae)	Knobwood (Mjafari)	Maceration is prepared from crushed seeds using water and then used to drench the cattle (2 L per cattle). Seed powders are administrated to the camels using 0.5 L of water (repeat once a day for 3 days). Infusion is prepared from the roots using water and then given to the animal	Oral	Diarrhoea, colds, coughs and pneumonia (Sori et al. 2004; Dharani et al. 2015)
Zingiber officinale (Zingiberaceae)	Ginger (Gingibil)	Maceration is prepared from ground dry stem using water and then applied on eye	Ophthalmic	Eye inflammation (Yigezu et al. 2014)

9.6 Conclusion

In Cameroon, an overwhelming majority of animal owners throughout the country rely on traditional healthcare practices to keep their animals healthy and to treat them when they are sick. Ethnoveterinary practices are suggested to play greater roles in livestock health care as an alternative or integral part of modern veterinary practices. Data from this study can be preserved and the utilized plants recorded for a sustainable use.

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Chapter 10
Ethnoveterinary Medicinal Plants Used in South Africa

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Keywords South African ethnoveterinary medicine · Venda · Limpopo · Plant diversity · Livestock · Poultry

10.1 Introduction

Ethnoveterinary use of plants dates back from ancient times and it has been part of the heritage of indigenous people throughout history. Many people in developing regions around the globe have been using these traditional practices to sustain their livestock health by preventing and controlling diseases. Diseases affecting livestock have a huge impact on the economy in terms of production losses, in particular affecting cultures where livestock is equated to wealth (McGaw and Eloff 2008). Ethnoveterinary medicine may be a highly useful treatment for common ailments, such as mild diarrhoea, skin diseases, intestinal worms and wounds. Ethnoveterinary medicinal knowledge is commonly passed on from generation to generation orally in South Africa as in many other countries, thus there is a concern that due to urbanisation and acculturation the information may be lost, or inadequate information may be passed on to future generations. There is consequently a critical need to document the available knowledge. Additionally, studies investigating the pharmacological activity and toxicity of traditional remedies are also warranted to support and promote use of effective, safe and relatively low cost animal treatments.

South Africa is home to a wide range of temperate flora consisting of about 24,000 plant species. This region is also home to a rich diversity of cultures and traditions which are reflected by the use of different plants as medicine (McGaw and Eloff 2008). It is estimated that about 60% people in the country use plants as medicine, because most regions in developing countries consist of developing farmers who have limited access to Western health services. According to Luseba and

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Tshisikhawe (2013), farmers prefer to use traditional remedies to treat their livestock because of the greater availability, easy accessibility, low costs and apparent effectiveness of these remedies. Additionally, farmers believe that plants are safe to use and that they have less side effects on their livestock, believing that there is no necessity for withdrawal periods before the consumption of meat from animals treated with herbal remedies (Luseba and Tshisikhawe 2013).

Due to its diverse cultures, South Africa has different ethnic groups that use different ethnoveterinary remedies, and studies done by Luseba and Van der Merwe (2006) and Maphosa and Masika (2010) showed that the relationship between plant remedy and disease depends on the locality of the plants. Farmers from different ethnic groups may therefore use different plants to treat the same diseases, because different ethnic groups are located in different parts of the country where the availability of different plants varies (Luseba and Van der Merwe 2006).

Research on the ethnopharmacological properties of South African plant remedies is a very productive research field yet little has been done to determine the biological activity of these ethnoveterinary plant remedies, particularly using methods relating to their traditional preparation (McGaw and Eloff 2008). Most studies focus on laboratory-based in vitro screening because it is expensive to perform in vivo tests and specialised facilities are required. It is also important to note that the lack of activity in the in vitro screening does not automatically correspond to the lack of efficacy of the traditional medicine, so it is advisable to document and study the methods of traditional preparation and administration of the medicine (McGaw and Eloff 2008).

In 2008, a review was published on the ethnoveterinary use of southern African plants and scientific evaluation of their medicinal properties (McGaw and Eloff 2008), and future research recommendations were proposed. The list of plants documented to have been used in ethnoveterinary medicine up to 2008, as well as biological activities tested, is reproduced in Table 10.1. The present chapter aims to investigate what further research has been done on documenting the ethnoveterinary use of southern African plants over the past 10 years, and noting what further bioactivity studies have been conducted.

10.2 Ethnoveterinary Knowledge in South Africa Up to 2008

South African researchers have engaged with different communities of different regions within the country with promising results. The Rapid Rural Appraisal (RRA) approach is mostly used to obtain information about ethnoveterinary medicine (McGaw and Eloff 2008). The RRA is an approach used for quickly obtaining a preliminary understanding of a situation where specific research techniques are chosen from a wide range of options and where there is an assumption that all the relevant parts of a local system cannot be known in advance. The local system is best understood by combining the expertise of a multidisciplinary team that includes locals, while combining information collected in advance, direct observations and

Table 10.1 Plants used in South Africa for ethnoveterinary purposes, and bioactivity of tested species (reported up to 2008)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Acanthaceae	*Hypoestes aristata* (Vahl) Soland. Ex Roem. and Schult.	Used to drench calves suffering from a condition referred to as white scours	Whole plant infusions		
Alliaceae	*Agapanthus praecox* Willd.	Diarrhoea in sheep and goats (Dold and Cocks 2001)	Roots		
Amaranthaceae	*Exomis microphylla* (Thunb.) Aellen	Endometritis and vaginitis (Dold and Cocks 2001)	Leaf decoction		
Amaryllidaceae	*Ammocharis coranica* (Ker-Gawl.) Herb.	Used medicinally for cattle (Gerstner 1938)	Unspecified parts	Alkaloids, organic acid and haemolytic saponin (Watt and Breyer-Brandwijk 1962)	
Amaryllidaceae	*Boophane disticha* (L.f.) Herb.	Redwater in cattle, constipation in cattle, used to facilitate healing of broken limbs (Dold and Cocks 2001); abortion (van der Merwe et al. 2001)	Bulb, root, bulb scales		
Amaryllidaceae	*Crinum delagoense* Verdoorn	Used medicinally for cattle (Gerstner 1939)	Unspecified parts	Unknown	
Amaryllidaceae	*Crinum moorei* Hook. F.	Used medicinally for cattle (Gerstner 1939)	Unspecified parts	Lycorine, cheryrilline, crinamidine, crinidine, dihydrocrinidine and powelline and phenols (Watt and Breyer-Brandwijk 1962)	
Amaryllidaceae	*Haemanthus albiflos* Jacq.	Healing of broken limbs (Dold and Cocks 2001)	Bulb		
Anacardiaceae	*Ozoroa paniculosa* (Sond.) R. and A. Fernandes	Abdominal problems in animals (Hutchings et al. 1996); diarrhoea, redwater, sweating sickness (van der Merwe et al. 2001)	Bark, root bark	Volatile oil (Watt and Breyer-Brandwijk 1962)	

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Anacardiaceae	*Protorhus longifolia* (Bernh.) Engl.	Heartwater and diarrhoea in cows (Dold and Cocks 2001)	Bark		
Anacardiaceae	*Rhus incisa* L. f.	Roots given to livestock as treatment for shock after an accident, bark given to cows for diarrhoea (Dold and Cocks 2001)	Root and bark decoctions		
Anacardiaceae	*Rhus lancea* L.f.	Diarrhoea, gallsickness (van der Merwe et al. 2001)	Roots, bark		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Anacardiaceae	*Sclerocarya birrea* (A. Rich.) Hochst.	Diarrhoea, fractures (van der Merwe et al. 2001)	Bark		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Apiaceae	*Heteromorpha trifoliata* (Wendl.) Eckl. and Zeyh.	Zulus use bark for colic, scrofula and vermifuge for horses (Gerstner 1938); Xhosa use roots for threadwork in horses (Watt and Breyer-Brandwijk, 1962); Redwater, gallsickness (Masika et al. 2000)	Bark, roots	Falcarindiol and sarisan (antifungal) (Villegas et al. 1988)	
Apocynaceae	*Acokanthera oppositifolia* (Lam.) Codd	Heartwater in goats and sheep, redwater in cattle, snakebite, anthrax, tapeworm, swollen limbs (Dold and Cocks 2001)	Leaves, roots		
Apocynaceae	*Secamone filiformis* (L.f.) J.H.Ross	Infectious diseases in cattle (van der Merwe, pers. comm.)	Aerial parts		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)

Apocynaceae	*Strophanthus speciosus* (Ward and Harv.) Reber	Given to cattle for snakebite (Hutchings et al. 1996)	Unspecified	Cardiac glycosides stropeside and christyoside (Watt and Breyer-Brandwijk 1962)	
Araceae	*Zantedeschia albomaculata* (Hook.) Baill.	Medicine for cattle (Jacot Guillarmod 1971)	Unspecified parts		
Araliaceae	*Cussonia spicata* Thunb.	Leaves applied in hot fomentations to goats paralysed in their hind quarters (Palmer and Pitman, 1972); bark used for retained placenta in stock, leaves used to treat endometritis and/or vaginitis in cows, bark decoction for gallsickness in cattle (Dold and Cocks 2001; Masika et al. 2000)	Leaves, bark		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Arecaceae	*Phoenix reclinata* Jacq.	Wash to treat footrot in sheep and goats (Dold and Cocks 2001)	Roots		
Asclepiadaceae	*Sarcostemma viminale* (L.) R. Br.	Stems used to encourage lactation in cows, galactagogue in cows (Dold and Cocks 2001); wounds and maggots (Luseba and van der Merwe 2006)	Stems, aerial parts		Antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Asclepiadaceae	*Secamone filiformis* (L. f.) J.H. Ross	Diarrhoea in cattle (Dold and Cocks 2001)	Stem		
Asparagaceae	*Asparagus laricinus* Burch.	Sores, redwater, uterine infections (van der Merwe et al. 2001)	Tubers		
Asparagaceae	*Asparagus setaceus* (Kunth) Oberm.	Used to treat livestock for shock after an accident (Dold and Cocks 2001)	Roots		
Asparagaceae	*Asparagus suaveolens* (Burch.) Oberm.	Retained placenta in cows (Dold and Cocks 2001); sores, redwater, uterine infections (van der Merwe et al. 2001)	Roots, tubers		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Asparagaceae	*Protasparagus virgatus* (Bak.) Oberm.	Anthelmintics for animals and humans (Watt and Breyer-Brandwijk 1962)	Root infusions or decoctions		
Asphodelaceae	*Aloe arborescens* Mill.	Used to drench sick calves (Hutchings et al. 1996)	Leaf decoctions	Aloin, barbaloin, aloe emodin, aloenin, polysaccharides, lectins and other compounds (Hutchings et al. 1996)	
Asphodelaceae	*Aloe cooperi* Bak.	Used to protect cattle from the ill effects of eating improper food (Watt and Breyer-Brandwijk 1962)	Smoke from burning leaves		
Asphodelaceae	*Aloe ferox* Mill.	Typhoid, ticks and lice in poultry, redwater in cattle (Dold and Cocks, 2001); Redwater, intestinal worms (Masika et al. 2000).	Leaves, juice from leaves		
Asphodelaceae	*Aloe greatheadii* var. *davyana* (Schönland) H.F.Glen and D.S.Hardy	Burns, general ailments, blood cleansing, internal parasites, eye infections (van der Merwe et al. 2001)	Leaves, roots, whole plant		
Asphodelaceae	*Aloe maculata* All.	Used for 'blood scours' in calves and enteritis and indigestion in poultry (Hutchings et al. 1996)	Leaf infusions		
Asphodelaceae	*Aloe marlothii* Berger	Newcastle disease in chickens (Luseba and van der Merwe 2006); gallsickness, parasites, diarrhoea, constipation, retained placenta, dystocia, maggots (van der Merwe et al. 2001)	Leaves		Antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007); anti-rickettsial (Naidoo et al. 2006); anti-babesial (Naidoo et al. 2005)

Asphodelaceae	*Aloe tenuior* Haw.	Retained placenta in cows, tapeworm, redwater, intestinal parasites (Dold and Cocks 2001)	Leaves		
Asphodelaceae	*Aloe zebrina* Baker	Wounds and maggots (Luseba and van der Merwe 2006); burns, general ailments, blood cleansing, internal parasites, eye infections (van der Merwe et al. 2001)	Fresh leaves, roots, whole plant		
Asphodelaceae	*Bulbine alooides* (L.) Willd.	Redwater in cattle (Dold and Cocks 2001)	Roots		
Asphodelaceae	*Bulbine asphodeloides* (L.) Willd.	Used to treat sick cattle and goats (Hutchings et al. 1996)	Unspecified parts		
Aspidiaceae	*Dryopteris athamantica* (Kunze) Kuntze	Retained placenta in cows by the Sotho (Jacot Guillarmod 1971)	Rhizome decoctions		
Aspidiaceae	*Polystichum* sp.	Administered to horses with bots (Hutchings et al. 1996)	Rhizome decoctions		
Asteraceae	*Arctotus arctotoides* (L.f.) O.Hoffm.	Heartwater in goats (Dold and Cocks 2001)	Whole plant		
Asteraceae	*Bidens pilosa* L.	Equine anthelmintics (Hutchings et al. 1996)	Unspecified	The polyacetylene phenylheptatriyene and chalcones (Graham et al. 1980; Hoffman and Hoelzl 1988)	
Asteraceae	*Brachylaena discolor* DC.	Anthelmintics for calves, sheep and goats (Hutchings et al. 1996)	Dried leaf milk infusions	Onopordopicrin (Zdero and Bohlmann 1987)	
Asteraceae	*Brachylaena elliptica* (Thunb.) DC.	Used for treating calves (Gerstner 1939)	Roots		
Asteraceae	*Brachylaena ilicifolia* (Lam.) Phill. and Schweick.	Diarrhoea in lambs (Dold and Cocks 2001)	Leaves		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Asteraceae	*Callilepis laureola* DC.	Used to kill maggots in cattle (Watt and Breyer-Brandwijk 1962)	Root paste	Atractyloside and its aglycone, atractyligenin (Candy et al. 1977)	
Asteraceae	*Dicoma anomala* Sond.	Gallsickness in stock animals; powdered plants used for sores and wounds on horses (Watt and Breyer-Brandwijk 1962)	Root decoctions	Germacranolides (Hutchings et al. 1996)	
Asteraceae	*Microglossa mespilifolia* (Less.) B.L. Robinson	Tonics for stock animals (Hutchings et al. 1996)	Infusions from leaves and stems	Epi-friedelinol and C_{17} acetylenic compounds (Bohlmann and Fritz 1979)	
Asteraceae	*Mikania capensis* DC.	Plants used for horse sickness (Gerstner 1939)	Unspecified		
Asteraceae	*Printzia pyrifolia* Less.	Used for treating calves (Gerstner 1939)	Roots	Matricaria ester and p-coumarate (Bohlmann and Zdero 1978a)	
Asteraceae	*Schkuhria pinnata* (Lam.) Thell.	Eye infections, pneumonia, diarrhoea, heartwater (van der Merwe et al. 2001)	Aerial parts		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Asteraceae	*Senecio oxyriifolius* DC.	Swellings in animals (Hutchings et al. 1996)	Leaves	A tricyclic sesquiterpenoid, angeloyl and bisabolenes (Bohlmann and Zdero 1978b)	
Asteraceae	*Senecio tamoides* DC.	Anthrax and 'quarter evil' in callte (Gerstner 1939)	Unspecified parts		

Asteraceae	*Vernonia mespilifolia* Less.	Heartwater in goats (Dold and Cocks 2001)	Stems		
Asteraceae	*Vernonia neocorymbosa* Hilliard	Used by Zulus to treat calves (Gerstner 1939); root decoctions administered by Lobedu as anthelmintics to donkeys (Hutchings et al. 1996); pounded leaf and root infusions administered by Vhavenda as anthelmintics to domestic animals (Mabogo 1990)	Roots, leaves	Squalene, vernolide and vernodalin from aerial parts, and 13-hydroxybisabol-2,10-dien-1-one and small amounts of onopordopicrin in roots (Bohlmann et al. 1983)	
Balanitaceae	*Balanites maughamii*	Diarrhoea in cattle (Luseba and van der Merwe 2006)	Leaves		
Boraginaceae	*Ehretia rigida* (Thunb.) Druce	Gallsickness in cattle (Hutchings et al. 1996); fractures (van der Merwe et al. 2001)	Roots		
Capparaceae	*Capparis sepiaria* L.	Used by Xhosa for gallsickness in stock (Watt and Breyer-Brandwijk 1962)	Root decoctions		
Capparaceae	*Capparis tomentosa*	Root ash paste applied to sore teats in cows; root infusions used for stomach ailments in animals, particularly diarrhoea in cattle (Watt and Breyer-Brandwijk 1962; Pujol 1990), root decoction for gallsickness in stock (Dold and Cocks 2001)	Paste made from root ashes, root infusions and decoctions	The alkaloids stachydrine (Dictionary of Natural Products 1996) and 3-hydroxy-4-methoxy-3-methyl-oxindole (Dekker et al. 1987)	
Celastraceae	*Cassine aethiopica* Thunb.	Used by Zulus to drench worm-infested calves (Watt and Breyer-Brandwijk 1962)	Milk or whey bark infusions		
Celastraceae	*Cassine transvaalensis* (Burtt Davy) Codd	Diarhoea (van der Merwe et al. 2001)	Bark		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Celastraceae	*Maytenus heterophylla* (Eckl. and Zeyh.) N.K.B.Robson	Administered by Zulus to stock animals for diarrhoea (Watt and Breyer-Brandwijk 1962)	Bark and leaf infusions	Dulcitol, a spermidine alkaloid, celacinnine, triterpenoids, maytansine (Hutchings et al. 1996)	
Celastraceae	*Mystroxylon aethiopicum* (Thunb.) Loes.	Heartwater in cattle, worms in calves, intestinal parasites (Dold and Cocks 2001)	Bark		
Chenopodiaceae	*Chenopodium album* L.	Decoctions made from plants mixed with *C. ambrosioides* administered to goats and sheep for anaemia (Hutchings et al. 1996)	Unspecified	Hydrocyanic acid, potassium oxalate, ascorbic acid, sitosterol, oleanic acid (Watt and Breyer-Brandwijk 1962; Hutchings et al. 1996)	
Chenopodiaceae	*Chenopodium ambrosioides* L.	Decoctions made from plants mixed with *C. album* administered to goats and sheep for anaemia (Hutchings et al. 1996)	Unspecified	Saponins (Watt and Breyer-Brandwijk 1962) flavonoids, quercetin, oxalic, malic and succinic acids, triterpenoid glycosides, chenopodoside A and B, amino acids, ascaridole (Hutchings et al. 1996)	
Colchicaceae	*Gloriosa superba* L.	Used to kill lice, for skin eruptions, tick infections and screw-worm on cattle (Gerstner 1939; Roberts 1990)	Corms	Colchicine, chelidonic acid various alkaloids and other constituents (Hutchings et al. 1996)	
Combretaceae	*Combretum caffrum* (Eckl. and Zeyh.) Kuntze	Conjunctivitis (Masika et al. 2000)	Drops from squeezed leaves used		Antibacterial, antifungal (Masika and Afolayan 2002)
Combretaceae	*Combretum erythrophyllum* (Burch.) Sond.	Small doses administered as fattening tonics to dogs (Watt and Breyer-Brandwijk 1962)	Roots		

Combretaceae	*Combretum paniculatum* Vent.	Fertility problems (Luseba and van der Merwe 2006)	Root bark		
Combretaceae	*Terminalia sericea* Burch. ex DC.	Wounds (Luseba and van der Merwe 2006); diarrhoea (van der Merwe et al. 2001)	Leaves, roots		
Convolvulaceae	*Seddera sufruticosa* Hallier f.	Fractures (van der Merwe et al. 2001)	Roots		
Cornaceae	*Curtisia dentata* (Burm. F.) C.A.Sm.	Heartwater in cows (Dold and Cocks 2001)	Bark		
Cucurbitaceae	*Cucumis africanus* L. f.	Used as animal medicines by the Xhosa (Hutchings et al. 1996)	Unspecified	Toxic cucurbitacins (Hutchings et al. 1996)	
Dioscoreaceae	*Dioscorea dregeana* (Kunth) Dur. and Schinz	Sores and wounds in animals and humans by Xhosa (Watt and Breyer-Brandwijk 1962)	Water heated in scooped out tuber	An alkaloid and organic acids (Watt and Breyer-Brandwijk 1962)	
Dioscoreaceae	*Dioscorea sylvatica* (Kunth) Eckl.	Swollen udders and uterine problems in cows (Watt and Breyer-Brandwijk 1962)	Lotions from boiled crushed inner parts of tubers	Diosgenin (Watt and Breyer-Brandwijk 1962)	
Dracaenaceae	*Sansevieria hyacinthoides* (L.) Druce	Fresh leaf sap applied to eyes of sheep and goats for conjunctivitis (Dold and Cocks 2001)	Leaf sap		
Ebenaceae	*Diospyros mespiliformis* Hochst. Ex A. DC.	For milk production (Luseba and van der Merwe 2006)	Bark		
Euphorbiaceae	*Clutia pulchella* L.	Drenches for griping pains in calves (Hutchings et al. 1996)	Milk infusions of leaves, stems and roots		
Euphorbiaceae	*Croton gratissimus* Burch. var. *gratissimus*	Pneumonia, tonic, fertility enhancement (van der Merwe et al. 2001)	Leaves, roots		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Euphorbiaceae	*Euphorbia cooperi* N.E.Br. ex A.Berger	Blackquarter (Luseba and van der Merwe 2006)	Aerial parts		
Euphorbiaceae	*Jatropha curcas* L.	Drench for constipation in cattle and goats (Luseba and van der Merwe 2006)	Seeds		
Euphorbiaceae	*Jatropha zeyheri* Sond.	General ailments, diarrhoea (Luseba and van der Merwe 2006)	Roots		Antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Euphorbiaceae	*Phyllanthus burchellii* Müll.Arg. and *P. parvulus* Sond.	Eye infections (van der Merwe et al. 2001)	Aerial parts		
Euphorbiaceae	*Ricinus communis* L.	Administered as a purgative to calves refusing to suckle (Hutchings et al. 1996); constipation, internal parasites (van der Merwe et al. 2001)	Powdered seed	Seeds contain a fixed oil, ricin, lipases and ricinine (Trease and Evans 1983).	Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Euphorbiaceae	*Spirostachys abbrevia* Sond.	Sap applied to cattle sores to kill maggots (Hutchings et al. 1996); sweating sickness (van der Merwe et al. 2001)	Sap, wood		
Euphorbiaceae	*Synadenium cupulare* (Boiss.) L.C. Wheeler	Eye infection, blackquarter (Luseba and van der Merwe 2006)	Milky latex		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)

Fabaceae	*Acacia decurrens* Willd.	Hastens oestrus (Masika et al. 2000)	Bark decoction		
Fabaceae	*Acacia karroo* Hayne	Diarrhoea in goats, intestinal parasites in goats, sheep, poultry and pigs (Dold and Cocks 2001); fractures and diarrhoea (van der Merwe et al. 2001)	Bark, leaves		
Fabaceae	*Acacia tortilis* (Forssk.) Hayne	Diarrhoea (van der Merwe et al. 2001)	Branch tips		
Fabaceae	*Adenopodia spicata* (E. Mey.) Presl	Powdered roots used by Zulus to fatten goats (Hutchings et al. 1996); Mfengu use bark for colds in horses (Watt and Breyer-Brandwijk 1962)	Roots, bark	Saponins (Watt and Breyer-Brandwijk 1962)	
Fabaceae	*Calpurnia aurea* (Ait.) Benth.	Zulus use plant to destroy maggots in sores (Bryant 1966)	Unspecified parts	Alkaloids (Hutchings et al. 1996)	
Fabaceae	*Calpurnia villosa* Harv.	The Sotho use plant infusions topically on maggot-infested sores on cattle (Gerstner 1939)	Unspecified parts	The alkaloid oroboidine (Hutchings et al. 1996)	
Fabaceae	*Cassia abbreviata* Oliv.	Drench for worm infestations (Luseba and van der Merwe 2006)	Bark		
Fabaceae	*Elephantorrhiza elephantina* (Burch.) Skeels	The Xhosa use roots for diarrhoea and dysentery in cattle, horses and humans (Watt and Breyer-Brandwijk 1962), root given to cows for mange (Dold and Cocks 2001); heartwater, blackquarter, appetite stimulant or tonic (Luseba and van der Merwe 2006); diarrhoea, heartwater, coughing, pneumonia (van der Merwe et al. 2001)	Roots, aerial parts and bulb	Tannin (Watt and Breyer-Brandwijk 1962)	Anti-rickettsial (Naidoo et al. 2006); anti-babesial (Naidoo et al. 2005)
Fabaceae	*Erythrophleum lasianthum* Corbishley	Lung sickness in cattle and abortions in dogs (Hutchings et al. 1996)	Bark	Seeds and bark contain erythrophleine (Watt and Breyer-Brandwijk 1962)	

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Fabaceae	*Indigofera frutescens* L. f.	Anthelmintics in animals and humans, especially roundworm (Watt and Breyer-Brandwijk 1962)	Root bark decoctions		
Fabaceae	*Indigofera sessilifolia* DC.	Diarrhoea in calves (Dold and Cocks 2001)	Roots		
Fabaceae	*Macrotyloma axillare* (E. Mey.) Verdc.	Administered to cows with swollen udders after calving (Hulme 1954)	Warm water leaf and stalk infusions		
Fabaceae	*Peltophorum africanum* Sond.	Tonic, diarrhoea (van der Merwe et al. 2001)	Bark, root bark		Antibacterial, antioxidant, anthelmintic (Bizimenyera et al. 2005, 2006a, b)
Fabaceae	*Pterocarpus angolensis* DC.	General illness, gallsickness, intestinal worms, blackquarter (Luseba and van der Merwe 2006)	Bark		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Fabaceae	*Schotia brachypetala* Sond.	Infectious diseases in cattle (van der Merwe, pers. comm.)			Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Fabaceae	*Schotia latifolia* Jacq.	Redwater in cattle (Dold and Cocks 2001)	Bark decoction		Antibacterial, antifungal (Masika and Afolayan 2002)

Fabaceae	*Senna italica* Mill.	Diarrhoea and gallsickness (Luseba and van der Merwe 2006); gallsickness, intestinal diseases, heartwater, anthrax, pneumonia (van der Merwe et al. 2001)	Bark, roots		
Fabaceae	*Tephrosia kraussiana* Meisn.	Plants used by Zulus for protecting cattle against quarter-evil and other diseases (Doke and Vilakazi 1972)	Unspecified parts	Roots may contain a saponin (Watt and Breyer-Brandwijk, 1962)	
Fabaceae	*Tephrosia macropoda* (E. Mey.) Harv.	Roots and seeds used for killing vermin on animals and humans (Gerstner 1941); leaf extracts used as anthelmintics for cattle (Bryant 1966)	Roots, seeds, leaves	Roots contain toxicarol and deguelin (Watt and Breyer-Brandwijk 1962)	
Geraniaceae	*Monsonia emarginata* (L. f.) L'Hérit	Stomach ailments in calves, lambs and humans (Watt and Breyer-Brandwijk 1962)	Unspecified parts	Phloroglucin tannin (Watt and Breyer-Brandwijk 1962)	
Geraniaceae	*Pelargonium luridum* (Andr.) Sweet	Administered to sick calves (Hutchings et al. 1996)	Leaf infusions	Coumarins in roots (Wagner and Bladt 1975)	
Geraniaceae	*Pelargonium reniforme* Curtis	Diarrhoea in goats and cows, heartwater in cattle, liver disorders in cattle and sheep (Dold and Cocks 2001)	Root decoction		
Geraniaceae	*Pelargonium sidoides* DC.	Used as anthelmintics for calves with *Ziziphus zeyheriana* Sond. (Watt and Breyer-Brandwijk 1962)	Decoctions of unspecified parts	Coumarins in roots (Wagner and Bladt 1975)	
Gesneriaceae	*Streptocarpus prolixus* C.B. Cl.	Administered by the Zulus as purgatives to cows (Hulme 1954)	Cold water leaf infusions		
Gunneraceae	*Gunnera perpensa* L.	Used to facilitate expulsion of afterbirth in animals and women (Gerstner 1939)	Roots	Bitter principle, celastrin (Watt and Breyer-Brandwijk 1962)	

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Hyacinthaceae	*Albuca* sp.	Purgative and vermifuge for animals and humans (Gerstner 1938)	Unspecified		
Hyacinthaceae	*Ledebouria cooperi* (Hook. F.) Jessop	Administered to cows to ensure a succession of calves of the same gender (Watt and Breyer-Brandwijk 1962)	Unspecified		
Hyacinthaceae	*Ledebouria revoluta* (L. f.) Jessop	Gallsickness in animals by the Xhosa (Watt and Breyer-Brandwijk 1962); bulb infusion for diarrhoea in goats, leaf decoction for gallsickness (Dold and Cocks 2001)	Bulbs, leaves		
Hyacinthaceae	*Scilla natalensis* Planch.	Administered to cattle with lung sickness (Hutchings et al. 1996)	Unspecified		
Hyacinthaceae	*Scilla nervosa* (Burch.) Jessop	Used as purges for calves (Gerstner 1941)	Unspecified		
Hyacinthaceae	*Urginea altissima* (L. f.) Baker	Intestinal parasites in cattle, retained afterbirth (Dold and Cocks 2001)	Bulb decoction		
Hyacinthaceae	*Urginea physodes* (Jacq.) Bak.	'Itch' in goats (Gerstner 1941)	Unspecified		
Htacinthaceae	*Urginea sanguinea* Schinz	General ailments, intestinal diseases, internal parasites, gallsickness, heartwater, redwater, sores, retained placenta (van der Merwe et al. 2001)	Bulbs		Anti-babesial (Naidoo et al. 2005)
Hypoxidaceae	*Hypoxis hemerocallidea* Fisch. and C.A. Mey. [and *Hypoxis rigidula* Baker]	Fertility enhancement, general ailments, heartwater, abortion (van der Merwe et al. 2001)	Corms		

Icacinaceae	*Apodytes dimidiata* E. Mey. Ex Arn.	Purgatives for calves (Gerstner 1938); worms in cattle (Hutchings et al. 1996)	Bark, leaves		
Iridaceae	*Crocosmia paniculata* (Klatt) Goldbl..	Used for bovine diarrhoea by the Sotho (Watt and Breyer-Brandwijk 1962)	Unspecified		
Iridaceae	*Dietes iridioides* (L.) Sweet ex Klatt	Tonics for goats (Hulme 1954); used by the Xhosa to prevent or treat stomach ailments in goats and sheep (Hutchings and Johnson 1986)	Ground rhizomes		
Iridaceae	*Watsonia densiflora* Bak.	Diarrhoea in calves by the Sotho (Watt and Breyer-Brandwijk 1962)			
Lamiaceae	*Leonotis leonurus* (L.) R. Br.	Pounded roots and leaves are added to drinking water to prevent sickness in poultry and are used for gallsickness in cattle (Hulme 1954); eye inflammation (Masika et al. 2000)	Roots, leaves, drops used from squeezed leaf for eyes	Volatile oil and diterpenoids (labdane type lactones) for example marrubin (Dictionary of Natural Products 1996)	
Lamiaceae	*Leonotis ocymifolia* (Burm. F.) Iwarsson	Pounded roots and leaves are added to drinking water to prevent sickness in poultry and are used for gallsickness in cattle (Hulme 1954)	Roots, leaves		
Lamiaceae	*Leucas capensis* (Benth.) Engl.	Gallsickness in stock (Dold and Cocks 2001)	Leaves		
Lamiaceae	*Marrubium vulgare* L.	Gallsickness in stock (Dold and Cocks 2001)	Leaves		
Lamiaceae	*Plectranthus laxiflorus* Benth.	Drenches for animals (Watt and Breyer-Brandwijk 1962)	Powdered aerial parts		
Lamiaceae	*Tetradenia riparia*	Used for gallsickness and fevers in cattle (Hutchings et al. 1996)	Leaves	A diterpene diol, ibozol, and related diterpenoids, large amounts of α-pyrones (Dictionary of Natural Products 1996)	

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Lamiaceae	*Teucrium africanum* Thunb.	Gallsickness in cattle, heartwater in goats and sheep, bloat in goats, anthrax (Dold and Cocks 2001)	Leaves		
Loganiaceae	*Strychnos decussata* (Pappe)	Roundworm in cows (Dold and Cocks 2001)	Bark infusion		
Loganiaceae	*Strychnos henningsii* Gilg.	Heartwater and diarrhoea in cattle (Dold and Cocks 2001)	Bark infusion		
Malvaceae	*Hibiscus malacospermus* E.Mey. ex Harv. and Sond.	Retained placenta, intestinal worms (Masika et al. 2000)	Root decoction		
Melianthaceae	*Bersama tysoniana* Oliv.	Used by the Xhosa for gallsickness in cattle (Watt and Breyer-Brandwijk 1962)	Bark decoctions		
Moraceae	*Ficus ingens* (Miq.) Miq.	Administered to cows to increase milk production by Zulus (Watt and Breyer-Brandwijk 1962) and Vhavenda (Mabogo 1990)	Bark decoctions	Tannin (Watt and Breyer-Brandwijk 1962)	
Moraceae	*Ficus sur* Forssk.	Zulus use leaf and bark infusions as bovine galactagogues (Hutchings et al. 1996); Vhavenda use root decoctions for retained placenta in cows (Watt and Breyer-Brandwijk 1962)	Leaves, bark, roots	Bark may contain tannin (Hutchings et al. 1996)	
Myrsinaceae	*Rapanea melanophloeos* (L.) Mez	Heartwater in cows (Dold and Cocks 2001)	Bark		
Myrtaceae	*Heteropyxis natalensis* Harv.	Drench for stock animals (Watt and Breyer-Brandwijk 1962)	Powdered leaves	Essential oils from ground dried leaves contain many constituents (Hutchings et al. 1996)	

Olacaceae	*Ximenia americana* L. var. *microphylla*	Internal parasites (van der Merwe et al. 2001)	Roots		
Oleaceae	*Olea europaea* L.	Leaves used for endometritis and vaginitis in cows, bark infusion for diarrhoea in goats, gallsickness in cattle, eye lotion for animals and humans (Dold and Cocks 2001)	Leaves, bark		
Orchidaceae	*Eulophia speciosa* (R. Br. Ex Lindl.) H. Bol.	Emetics for animals and humans (Gerstner 1941)	Root infusions		
Pedaliaceae	*Dicerocaryum eriocarpum* (Dcne.) J.Abels [and *D. senecioides* (Kltzsch.) J.Abels]	Dystocia, drench for retained placenta (Luseba and van der Merwe 2006; van der Merwe et al. 2001)	Aerial parts, roots, whole plant		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Pedaliaceae	*Harpagophytum procumbens* DC.	Retained placenta (van der Merwe et al. 2001)	Fruit		
Poaceae	*Cymbopogon marginatus* (Steud.) Stapf ex Burtt Davy	Gall sickness in animals (Jacot Guillarmod 1971)	Unspecified		
Phytolaccaceae	*Phytolacca heptandra* Retz.	The Xhosa use roots for lung sickness in cattle (Watt and Breyer-Brandwijk 1962)	Roots		
Phytolaccaceae	*Phytolacca octandra* L.	Lung sickness in cattle (Watt and Breyer-Brandwijk 1962)	Root infusions	Triterpenoid saponins, known as yiamoloside B (Moreno and Rodriguez 1981)	
Pittosporaceae	*Pittosporum viridiflorum* Sims	Gallsickness (Masika et al. 2000)	Bark decoction		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Plumbaginaceae	*Plumbago auriculata* Lam.	Diarrhoea in cows (Dold and Cocks 2001)	Roots		
Plumbaginaceae	*Plumbago zeylanica* L.	Pneumonia (van der Merwe et al. 2001)	Roots		
Podocarpaceae	*Podocarpus falcatus* (Thunb.) R. Br. Ex Mirb.	Distemper in dogs (Dold and Cocks 2001)	Leaf decoction		
Podocarpaceae	*Podocarpus latifolius* (Thunb.) R. Br. Ex Mirb.	Distemper in dogs, gallsickness in cattle (Dold and Cocks 2001; Masika et al. 2000)	Leaf, root or bark decoction		
Polygalaceae	*Polygala hottentotta* Presl	Anthrax (Jacot Guillarmod 1971)	Unspecified parts		
Polygonaceae	*Emex australis* Steinh.	Threadworm in horses (Hutchings et al. 1996)	Leaf decoctions	Anthraquinones (Watt and Breyer-Brandwijk 1962)	
Polygonaceae	*Rumex lanceolatus* Thunb.	Used with *Euclea coriacea* A. DC. To treat gallsickness in stock animals (Jacot Guillarmod 1971)	Unspecified parts	Chrysophanic acid, emodin and volatile oil (Watt and Breyer-Brandwijk 1962)	
Proteaceaae	*Protea caffra* Meisn.	Enemas given to calves with bloody diarrhoea (Hutchings et al. 1996)	Root bark decoctions		
Proteaceae	*Protea welwitschii* Engl.	Dysentery and diarrhoea in calves and humans (Watt and Breyer-Brandwijk 1962)	Decorticated root infusions		
Ptaeroxylaceae	*Ptaeroxylon obliquum* (Thunb.) Radlk.	Anthrax remedy, for ticks in cattle (Hutchings et al. 1996)	Wood	Powdered wood is irritating and induces sneezing (Hutchings et al. 1996); timber has high oil and resin content (Watt and Breyer-Brandwijk 1962)	

Ranuncluaceae	*Clematis brachiata* Thunb.	Vermifuge and for bots in horses (Hutchings et al. 1996)	Infusions from shoots and leaves	Contains anemonol (Watt and Breyer-Brandwijk 1962)	
Rhamnaceae	*Berkhemia zeyheri* (Sond.) Grubov	Infectious diseases in cattle (van der Merwe, pers. comm.)	Bark		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al., 2007)
Rhamnaceae	*Ziziphus mucronata* Willd.	Fertility enhancement, sores, burns (van der Merwe et al. 2001)	Roots, leaves		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Rhamnaceae	*Ziziphus zeyheriana* Sond.	Diarrhoea, internal parasites, general ailments (van der Merwe et al. 2001)	Root-stock		
Rosaceae	*Prunus persica* (L.) Batsch.	Leaf decoction for diarrhoea in lambs and kid goats, roots for broken bones (Dold and Cocks 2001)	Leaf decoctions, roots		
Rubiaceae	*Pentanisia prunelloides* (Klotzsch ex Eckl. and Zeyh.) Walp. subsp. *prunelloides*	Used by Xhosa to aid expulsion of retained animal or human placenta (Watt and Breyer-Brandwijk 1962)	Root decoctions		
Rutaceae	*Clausena anisata* (Willd.) Hook. F. Ex Benth.	Dysentery in cattle (Hutchings et al. 1996)	Bark infusions	Terpenoid hydrocarcbons, alkaloids, coumarins and many other compounds (Hutchings et al. 1996)	

(continued)

Table 10.1 (continued)

Rutaceae	*Zanthoxylum capense* (Thunb.) Harv.	Gallsickness in stock (Dold and Cocks 2001)	Leaves, root decoction		
Rutaceae	*Zanthoxylum davyi* (Verdoorn) Waterm.	Administered as tonics to animals and humans (Hutchings et al. 1996)	Root decoctions		
Salicaceae	*Salix* L. spp.	Retained placenta (Masika et al. 2000)	Decoction or infusion of unspecified parts		Antibacterial, antifungal (Masika and Afolayan 2002)
Salvadoraceae	*Azima tetracantha* Lam.	Dystocia in cows (Dold and Cocks 2001)	Root		
Sapindaceae	*Hippobromus pauciflorus* (L. f.) Radlk.	Leaf and root infusions used to clear mucus from noses of sheep and goats (Watt and Breyer-Brandwijk 1962); root infusions given to stock animals with coughs (Hutchings et al. 1996); leaf sap used for inflamed eyes in animals and humans (Watt and Breyer-Brandwijk 1962; Masika et al. 2000); bark used for heartwater and diarrhoea in cattle (Dold and Cocks 2001)	Leaf and root infusions or decoctions, leaf sap, bark	Resinous and oily substances in wood and leaves (Watt and Breyer-Brandwijk 1962)	Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Sapindaceae	*Pappea capensis* Eckl. and Zeyh.	Used medicinally by Zulus for calves (Gerstner 1939)	Unspecified parts		
Sapotaceae	*Englerophytum magalismontanum* Krause	Fertility enhancement (van der Merwe et al. 2001)	Roots		

		tonics to calves and goats (Hutchings et al. 1996); Xhosa use bark for gallsickness in stock (Watt and Breyer-Brandwijk 1962); bark decoction used for redwater in cattle (Dold and Cocks 2001)	parts; bark	leucanthocyanidins from bark (Hutchings et al. 1996)	
Solanaceae	*Datura stramonium* L.	Powdered leaves are applied by Zulus to animal and human bruises and wounds to draw out inflammation and pus (Watt and Breyer-Brandwijk 1962)	Powdered leaves	Alkaloids including hyoscyamine and hyoscine (Oliver-Bever 1986)	
Solanaceae	*Nicotiana tabacum* L.	Eye infections (van der Merwe et al. 2001)	Leaves		
Solanaceae	*Solanum aculeastrum* Dun.	Ringworm in cattle and horses and also for anthrax (Hutchings et al. 1996)	Fruit	Solanine (Watt and Breyer-Brandwijk 1962)	
Solanaceae	*Solanum capense* L.	Fruit pulp used by Xhosa for warts and ringworm in animals and humans, fruit sap for sores, distemper and sore eyes in dogs (Watt and Breyer-Brandwijk 1962)	Fruit		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Solanaceae	*Solanum hermannii* Dun.	Fruit sap and leaf paste used for sores on sheep and horses by Xhosa and Sotho (Watt and Breyer-Brandwijk 1962)	Fruit, leaves	Solanin, solanidine, azosolanidin, quinhydrone solasonine, solasodine, solasodamine from fruit (Watt and Breyer-Brandwijk 1962)	
Solanaceae	*Solanum incanum* L.	Sores (van der Merwe et al. 2001)	Roots		
Solanaceace	*Solanum panduriforme* E. Mey.	Diarrhoea (van der Merwe et al. 2001)	Fruit sap		
Solanaceae	*Solanum lichtensteinii* Willd.	Respiratory problems (Luseba and van der Merwe 2006)	Aerial parts		
Solanaceae	*Solanum mauritianum* Scop.	Dystocia in cows (Dold and Cocks 2001)	Roots		
Solanaceae	*Withania somnifera* (L.) Dun.	Used to stimulate milk production in cows (Gerstner 1941); roots used for black gallsickness in cattle (Hutchings et al. 1996); diarrhoea (van der Merwe et al. 2001)	Unspecified parts, roots	Many compounds including choline, tropanaol, glycowithanolides, withanolides, withaferine and withasomnine (Hutchings et al. 1996 and references therein)	
Sterculiaceae	*Dombeya rotundifolia* (Hochst.) Planch.	Newcastle disease in chickens (Luseba and van der Merwe 2006); infectious diseases in cattle (van der Merwe, pers. comm.)	Leaves and flowers		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Thymelaeaceae	*Gnidia capitata* L.f.	Heartwater in cows, anthrax (Dold and Cocks 2001)	Root decoction		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Thymelaeaceae	*Gnidia kraussiana* Meisn.	Preparations injected near the site of fractured limbs of stock animals by the Sotho (Jacot Guillarmod 1971)	Unspecified parts	Flavone heteroside from roots, toxic diterpenoid fraction, polysacchardies daphnane orthoesters (Hutchings et al. 1996)	

Tiliaceae	*Grewia flava* DC.	Fertility enhancement (van der Merwe et al. 2001)	Roots		
Tiliaceae	*Grewia occidentalis* L.f.	Gallsickness in stock (Dold and Cocks 2001)	Leaves		
Tiliaceae	*Triumfetta sonderi* L.	Retained placenta (van der Merwe et al. 2001)	Root bark		
Typhaceae	*Typha capensis* (Rohrb.) N.E. Br.	Decoctions taken or applied externally to aid expulsion of afterbirth in animals and humans (Roberts 1990)	Unspecified parts	Quercetin 3′dimethyl ether 4′glucoside from leaf (Hutchings et al. 1996)	
Urticaceae	*Pouzolzia mixta* Solms	Retained placenta, bloat, vaginal discharge (van der Merwe et al. 2001)	Roots, leaves, stems		Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007)
Verbenaceae	*Clerodendrum glabrum* E. Mey.	Unspecified parts are used as purgatives for calves (Hutchings et al. 1996); The Sotho and Swazi use topical leaf decoctions to prevent parasites developing in animal wounds (Watt and Breyer-Brandwijk 1962). The Tswana use leaf infusions and bark scrapings as anthelmintics for dogs, calves and donkeys (Roberts 1990)	Leaves, bark		
Verbenaceae	*Lantana rugosa* Thunb.	Pastes or infusions used for animal and human eye complaints (Watt and Breyer-Brandwijk 1962)	Leaves	Volatile oil and the alkaloid lantanin (Watt and Breyer-Brandwijk 1962).	
Verbenaceae	*Vitex zeyheri* Sond. ex Schauer	Eye infections (van der Merwe et al. 2001)	Leaves		

(continued)

Table 10.1 (continued)

Family	Species	Indication	Plant part used	Chemical constituents	Screened for activity
Vitaceae	*Cissus quadrangularis* L.	Used by Zulus as a drench for sick horses (Watt and Breyer-Brandwijk 1962), aerial parts used as poultice for wounds, lumpy skin disease and as tick repellent (Luseba and van der Merwe 2006)	Aerial parts	A steroidal mixture and triterpenoids (Hutchings et al. 1996)	Antibacterial, anthelmintic, brine shrimp toxicity (McGaw et al. 2007); antibacterial, anti-inflammatory, mutagenic (Luseba et al. 2007)
Vitaceae	*Cyphostemma natalitium* (Szyszyl.) J. V. D. Merwe	Used by Zulus for colic in cattle (Gerstner 1939)			
Vitaceae	*Rhoicissus digitata* (L. f.) Gilg and Brandt	Cattle diseases (Hutchings et al. 1996)	Tubers		
Vitaceae	*Rhoicissus tomentosa* (Lam.) Wild and Drum.	Anthelmintics for calves (Watt and Breyer-Brandwijk 1962)	Roots		
Vitaceae	*Rhoicissus tridentata* (L. f.) Wild and Drum.	Cattle diseases (Pujol 1990), diarrhoea in goats and sheep (Dold and Cocks 2001); heartwater, redwater, internal parasites, general ailments, abortion (van der Merwe et al. 2001)	Tubers		Anti-babesial (Naidoo et al. 2005)
Zamiaceae	*Stangeria eriopus* (Kunze) Baill.	Internal parasites in livestock (Dold and Cocks 2001)	Rootstock		
Zingiberaceae	*Siphonochilus aethiopicus* (Schweinf.) B.L. Burtt	Administered to horses as prophylactics against horse sickness (Watt and Breyer-Brandwijk 1962)	Rhizome infusions	Volatile oil with a characteristic sesquiterpenoid, α-terpineol and other monoterpenoids (Van Wyk et al. 1997)	
Zygophyllaceae	*Tribulus terrestris* L.	Retained placenta, bloat (van der Merwe et al. 2001)	Whole plant, aerial parts		

Reprinted from McGaw and Eloff (2008), Copyright (2008), with permission from Elsevier semi-structured interviews. Time should be structured to ensure team interaction as part of an iterative process.

The use of traditional remedies to treat animal diseases is widely used amongst small-scale farmers of different ethnic groups including Tswana, Tsonga, Xhosa and Zulu, largely because of low cost, convenience and ease of administration (McGaw and Eloff 2008). Since information about traditional uses of many South African plants have been documented in only several books and journal articles, the review by McGaw and Eloff (2008) focused on the compilation of a complete systematic ethnobotanical record as EVM knowledge was rapidly disappearing and extinction was a threat as the plants may be over exploited.

It was found in the 2008 review that about 200 plant species from over 80 families were used as ethnoveterinary medicine to treat common diseases such as retained placenta, diarrhoea, gallsickness, fractures, eye inflammation, general unwellness, fertility problems, gastrointestinal ailments, heartwater, helminthosis, coughing, redwater and reduction of ticks in cattle, goats, sheep and poultry (McGaw and Eloff 2008).

The methods of preparation as well as application and dosages are critical factors to account for when evaluating a traditional remedy. According to Van der Merwe et al. (2001) it is believed that the small amounts of plant material used in medicines is the reason for the scarcity of reported toxic effects. McGaw and Eloff (2008) recommended that further research be done to optimise dosing and concentrations of EVM remedies.

10.3 Biological Activity of EVM Plants Studied Up to 2008

Out of the 200 plant species that were recorded in the study of McGaw and Eloff (2008), only 27 species had been screened for biological activity in targeted assays relating to ethnoveterinary use. Plants that were tested for antibacterial activity were 25, anthelmintic 17, brine shrimp toxicity 15, anti-inflammation 10, mutagenicity 7, antifungal 3 and anti-babesial were 3. In ethnoveterinary practices, water is the most commonly used solvent to prepare traditional medicine but in terms of the laboratory bioassays, organic solvents such as methanol, ethanol, dichloromethane, acetone, hexane and chloroform are commonly used to prepare the plant extracts.

Antibacterial activity seems to be the most commonly studied biological activity as 25 out of 27 plant species were tested for antibacterial activity, and the microplate serial dilution technique by Eloff (1998) was the most used technique to determine antibacterial and antifungal activity (McGaw and Eloff 2008). *Escherichia coli*, *Enterococcus faecalis*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* are commonly used bacterial strains as they are recommended by the National Committee for Clinical Laboratory Standards. In antifungal assays, *Candida albicans, Cryptococcus neoformans* and *Aspergillus fumigatus* were the most popular strains (McGaw and Eloff 2008). The anti-babesial in vitro assay was done using the cell culture based anti-babesial test exposing *Babesia caballi* cultures to plant extracts, and the acetone extract of *Elephantorrhiza elephantina* rhizome was active against *Babesia caballi* (Naidoo et al. 2005). An in vitro *Ehrlichia ruminantium* culture system was used to test the anti-rickettsial activity of plant extracts and again *Elephantorrhiza elephantina* and *Aloe marlothii* acetone extracts were active (Naidoo et al. 2006).

10.4 Updated Information on Ethnoveterinary Use of Plants (2008–2018)

In Table 10.2, a total of 83 plant species belonging to 47 families were identified from studies on ethnoveterinary surveys published between 2008 and 2018. The majority of surveys done and plants identified were amongst the Xhosa ethnic group of the Eastern Cape Province. Since 2008, relatively few surveys have been done to obtain ethnoveterinary knowledge amongst different communities of various ethnic groups. In a survey done by Luseba and Tshisikhawe (2013), it was found that over 33 plant species belonging to over 21 families were used as ethnoveterinary medicine, with the Fabaceae family having more plant species. This is likely to be mostly owing to the large size of the family. The survey was done in the Vhembe (Venda speaking) region in Limpopo province and 37 individuals were interviewed. In another survey done by Kambizi (2016), it was found that the communities of Pondoland (Xhosa-speaking) also use indigenous plant species for ethnoveterinary purposes. This survey revealed that 23 plants from 18 families were used to treat livestock. Farmers of the Amatola Basin (Xhosa-speaking) in the Eastern Cape province indicated that wounds and myiasis were serious health problems in cattle and resulted in a decrease in animal production, which is responsible for severe economic losses (Soyelu and Masika 2009).

Intestinal parasites are a major problem in animals worldwide, causing heavy production losses in animals. They are commonly found in developing countries, mainly because of poor management practices and inadequate control measures, in association with warm temperatures. It was discovered that in most ethnoveterinary surveys, medicinal plants are commonly used for the control of these parasites (Maphosa and Masika 2010). It was found that 28 plant species from 20 families were used as ethnoveterinary medicine to treat gastro-intestinal parasites in goats in a survey done in the Eastern Cape province (Maphosa and Masika 2010). Thirty individuals were interviewed, and similar plant species were also identified in a similar survey including both intestinal and external parasites done by Sanhokwe et al. (2016) in Kwezi and Ntambethemba villages in the Eastern Cape Province. In another survey done by Mwale and Masika (2009), it was found that most of the poultry farmers interviewed used over nine plant species to treat gastro-intestinal parasites on their chickens. The main medicinal plant used for controlling these parasites in chickens was *Aloe ferox*. Again, *Aloe ferox* was the most commonly used plant along with *Prunus persica* and *Phytolacca heptandra* in a survey done by

Table 10.2 Plant species reported in ethnoveterinary studies (2008–2018)

Family	Species	Indication, plant part, preparation and administration	Screened for activity
Agapanthaceae	*Agapanthus praecox* Willd.	Intestinal parasites in goats and black quarter in cattle. Leaves are ground, soaked in water overnight and 500 ml dosed for goats. Roots and leaves are crushed and soaked with water and administered orally (Maphosa and Masika 2010; Sanhokwe et al. 2016; Mthi et al. 2018)	Genotoxicity and anti-genotoxicity (Makhuvele et al. 2018)
Amaryllidaceae	*Clivia* spp.	Root infusion used for stomach problems (Maphosa and Masika 2010)	
Anacardiaceae	*Harpephyllum caffrum* Bernh.	Bark decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
	Searsia lancea (L.f.) F.A.Barkley	Leaves are boiled, and 1 l given to adults and 500 ml to calves for lumpy skin disease in cattle (Luseba and Tshisikhawe 2013)	Antibacterial screening, synergy studies and phenolic content (Vambe et al. 2018)
Apiaceae	*Alepidea amatymbica* Eckl. & Zeyh.	Bulb infusion used to treat heartwater and skin diseases (Kambizi 2016)	
	Centella asiatica (L.) Urb.	Plant (tuber and root) is cut and boiled, cooled and given to chickens to drink for internal parasites (Mwale and Masika 2009)	
	Centella coriacea Nannf.	Decoction of chopped bark is sieved and approximately 500 mL dosed to goats for intestinal problems (Maphosa and Masika 2010; Sanhokwe et al. 2016)	
Apocynaceae	*Acokanthera oppositifolia* (Lam.) Codd	Leaves are ground, boiled, cooled and used to drench animals for intestinal and external parasites in goats and black-quarter in cattle. Dose with 1 L bottle for adults and a 300 mL bottle for young ones. For cattle, leaves are crushed with water and administered orally (Maphosa and Masika 2010; Sanhokwe et al. 2016; Mthi et al. 2018)	
	Carissa bispinosa (L.) Desf. ex Brenan	Bulb is ground and 1 L extract given to cows for calving difficulties (Luseba and Tshisikhawe 2013)	
	Xysmalobium undulatum (L.) W.T.Aiton	Plant (tuber and root) is cut and boiled, cooled and given to chickens to drink for internal parasites (Mwale and Masika 2009)	
Araliaceae	*Cussonia spicata* Thunb.	Bark is ground, soaked overnight and 300 ml dosed to goats against intestinal parasites(Maphosa and Masika 2010; Sanhokwe et al. 2016)	

(continued)

Table 10.2 (continued)

Family	Species	Indication, plant part, preparation and administration	Screened for activity
Asparagaceae	*Agave sisalana* Perrine	Leaves are cut and mixed with cold water or boiled and cooled before giving to chickens to drink for internal parasites (Mwale and Masika 2009)	
	Asparagus falcatus L.	Whole plant infusion used for constipation in cattle (Kambizi 2016)	
	Asparagus africanus Lam.	Infusion of the bulb is used for heartwater (Kambizi 2016)	
Asphodelaceae	*Aloe arborescens* Mill.	Leaf decoction used against intestinal parasites in goats (Maphosa and Masika, 2010)	Antibacterial and cytotoxicity (Sserunkuma et al. 2017)
	Aloe ferox Mill.	Leaves are crushed and juice applied to skin (mites and ticks) or mixed with drinking water to form decoctions and infusions to treat intestinal and external parasites in goats (Maphosa and Masika, 2010; Sanhokwe et al. 2016). Leaf infusion is used as a wash or applied as a dressing on wounds for wound infections in cattle (Soyelu and Masika 2009). Leaves are chopped and mixed with cold water; or mixture is boiled before giving to chickens as drinking water to treat internal parasites (Mwale and Masika 2009)	
	Aloe marlothii Berger	Broad leaves are ground, juice is squeezed in water and chickens allowed to drink for liver problems and Newcastle disease (Luseba and Tshisikhawe 2013)	
	Gasteria bicolor Haw.	Leaf infusion used for intestinal parasites in goats (Maphosa and Masika 2010)	
	Bulbine latifolia (L.F.) Spreng.	Leaves used for intestinal parasites in goats. Ground leaves are boiled and applied to skin against ticks, or drench with 1 L (Maphosa and Masika 2010; Sanhokwe et al. 2016)	
	Bulbine frutescens (L.) Willd.	Whole plant infusion used for intestinal parasites in goats (Maphosa and Masika 2010)	
	Bulbine abyssinica	Leaf decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
Asteraceae	*Haplocarpha scaposa* Harv.	Root decoction used as a wash for wound infections in cattle (Soyelu and Masika 2009)	

	Helichrysum splendidum (Thunb.) Less.	Leaves are burnt to ash and smoke will drive away external parasites; ash is placed in incubators where there are incubating hens (Mwale and Masika 2009)	
	Tagetes minuta L.	Mix the leaves with periperi (*Capsicum frutescence*), grind and apply the mixture to control ticks on cattle (Luseba and Tshisikhawe 2013). Roots are boiled, I L given to cows and 500 ml to calves for diarrhoea (Luseba and Tshisikhawe 2013). Leaves are placed where there are external parasites of chickens or in a hatchery (Mwale and Masika 2009)	
	Vernonia corymbosa (L.f.) Less	Roots are ground and mixed with water. One litre given to cows and 500 ml to young calves to treat worms (Luseba and Tshisikhawe 2013)	
Balanophoraceae	*Sarcophyte sanguinea* Sparrm.	Whole plant is crushed with water and administered orally for black quarter (Mthi et al. 2018)	
Boraginaceae	*Ehretia rigida* (Thunb.) Druce	Boil the roots; give the cow in 1 l and ½ a litre to young animals for eating problems in cattle (Luseba and Tshisikhawe 2013)	
Cannabaceae	*Trema orientalis* (L.) Blume	Leaves are ground, mixed with water and given to animals for gallsickness (Luseba and Tshisikhawe 2013)	Antibacterial, anti-inflammatory and genotoxicity (Madikizela et al. 2012)
Capparaceae	*Maerua angolensis* DC.	Leaves are ground, mixed with water and 1 L given to cows and 500 ml to calves to treat eating problems (Luseba and Tshisikhawe 2013)	
Capparidaceae	*Capparis sepiaria* L.	Root infusion used to treat intestinal parasites in goats (Maphosa and Masika 2010)	
	Cussonia spicata Thunb.	Bark infusion used to treat heartwater (Kambizi 2016)	
Celastraceae	*Elaeodendron transvaalense* (Burtt Davy) R.H.Archer	Fruits are ground, mixed with water and give 1 l to cows and 500 ml to calves for worms in cattle (Luseba and Tshisikhawe 2013)	
Clusiaceae	*Garcinia livingstonei* T.Anderson	Fresh leaf juice is squeezed into the eye of the animal for eye problems (Luseba and Tshisikhawe 2013)	
Combretaceae	*Combretum molle* R.Br. ex G.Don	A leaf infusion is administered: 1 L to cows and 500 ml to calves for gut conditions (Luseba and Tshisikhawe 2013)	

(continued)

Table 10.2 (continued)

Family	Species	Indication, plant part, preparation and administration	Screened for activity
	Terminalia sericea Burch. ex DC.	Boil roots and give the animal in 1 l, 500 ml to young ones (mix with milk) for diarrhoea. Ground roots are mixed with water and applied on ticks and wounds (Luseba and Tshisikhawe 2013)	Antiparasitic and anti-inflammatory (Nair et al. 2018)
Ebenaceae	*Diospyros lycioides* Desf.	Leaves are ground, mixed with water and applied on the affected area for ticks in cattle (Luseba and Tshisikhawe 2013	
Euphorbiaceae	*Pseudolachnostylis maprouneifoloia* Pax	Bark is ground, mixed with water and sieved; 1 l given to cows and 500 ml to calves (Luseba and Tshisikhawe 2013)	
	Synadenium cupulare (Boiss.) L.C. Wheeler	Strike with latex branch on the affected area for black quarter (Luseba and Tshisikhawe 2013). Brancj is cut and oozing latex applied on the limb to treat lumpy skin disease (Luseba and Tshisikhawe 2013)	
Fabaceae	*Acacia karroo* Hayne	Crushed leaves are used for wound infections in cattle (Soyelu and Masika 2009)	
	Bolusanthus speciosus (Bolus) Harms	Pounded roots and bulb are immersed for 12 h, and 2 l are given f or 3 days for retained placenta in cattle (Luseba and Tshisikhawe 2013)	
	Calpurnia aurea (Ait.) Benth.	Leaf infusion used as a lotion for wounds; also effective against maggot infested wounds (Soyelu and Masika 2009)	Antibacterial and cytotoxicity (Elisha et al. 2017)
	Dalbergia obovata E.Mey.	Leaves and bark are crushed and mixed with water and administered orally for paratyphoid (Mthi et al. 2018)	
	Elephantorrhiza burkei Benth.	Bulb and roots are ground, mixed with water and given to cattle for diarrhoea (Luseba and Tshisikhawe 2013)	
	Elephantorrhiza elephantina (Burch.) Skeels	Roots are ground and boiled in water for about 30 min until the water turns red. Dose 300 mL or spray the animals for mites and ticks. Bark is boiled to form a decoction and remedy is administered orally to goat for intestinal and external parasites (Maphosa and Masika 2010)	
	Erythrina caffra Thunb.	Bark infusion used to treat heartwater (Kambizi 2016)	Antibacterial, antioxidant and cytotoxicity (Dzoyem et al. 2014)

	Milletia grandis (E.Mey) Skeels	Leaves soaked in cold water and given to chickens to drink for internal parasites (Mwale and Masika 2009)	
	Pterocarpus angolensis DC.	Bark is soaked in water and 1 l given to cows and 500 ml to calves for not eating (Luseba and Tshisikhawe 2013)	
	Schotia latifolia Jacq.	Bark decoction given for intestinal parasites in goats (Maphosa and Masika 2010). Bark decoction used as a wash for wounds in cattle (Soyelu and Masika 2009)	
	Senna petersiana (Bolle) Lock	Leaves are soaked and 500 ml given to goat for general illnesses (Luseba and Tshisikhawe 2013)	
	Xanthocersis zambesiaca (Baker) Dumaz-le-Grand	Bark is ground, boiled and 1 l given to cows and 500 ml to calves for eating problems (Luseba and Tshisikhawe 2013). Bark is ground, mixed with salt and give to cattle or leaves are soaked for 12 hours and 2 l given to animals (Luseba and Tshisikhawe 2013)	
Geraniaceae	*Pelargonium reniforme* Curtis	Tuber decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
Gunneraceae	*Gunnera perpensa* L.	Tuber is crushed and boiled and 300 ml given to goats for intestinal parasites (Maphosa and Masika 2010; Sanhokwe et al. 2016). Leaves are chopped, cold water is added and given to chickens to drink for internal parasites (Mwale and Masika 2009)	Antinociceptive and anti-inflammatory (Nkomo et al. 2010)
Hyacinthaceae	*Albuca setosa* Jacq.	Tuber is crushed, boiled and dosed with a 500 ml bottle for intestinal problems in goats (Sanhokwe et al. 2016)	
Hypoxidaceae	*Hypoxis argentea* Harv. ex Baker	Tuber decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
Iridaceae	*Gladiolus dalenii* Van Geel	Fresh bulb is ground, put in a sac and juice is squeezed on infected eyes (Luseba and Tshisikhawe 2013). The stem is mixed with leaves of *Dicerocaryum eriocarpum*, crushed and given in a 1 l bottle for eating problems in animals (Luseba and Tshisikhawe 2013)	
Lamiaceae	*Clerodendrum glabrum* E.Mey.	Leaf infusion used for intestinal parasites in goats (Kambizi 2016)	

(continued)

Table 10.2 (continued)

Family	Species	Indication, plant part, preparation and administration	Screened for activity
	Teucrium trifidum Retz.	Leaf infusion used for intestinal parasites in goats (Maphosa and Masika 2010)	
	Leonotis leonurus (L.) R. Br.	Leaf decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
	Ocotea bullata (Burch.) E. Meyer in Drege	Bark decoction given to goats for intestinal parasites (Maphosa and Masika 2010)	
Loganiaceae	*Strychnos henningsii* Gilg.	Bark decoction used for intestinal parasites in goats and black quarter in cattle (Maphosa and Masika 2010; Mthi et al. 2018)	
Lauraceae	*Cassytha filiformis* L.	Stem is mixed with leaves of *Dicerocaryum erriocarpum,* crushed and boiled and 1 l given for calving difficulties (Luseba and Tshisikhawe 2013)	
Lobeliaceae	*Cyphia stramonium* N.E.Br.	Leaf infusion used for shivering endlessly (Kambizi 2016)	
Meliaceae	*Turraea obtusifolia* Hochst	Crushed leaves are applied directly on wounds (Luseba and Tshisikhawe 2013)	
Menispermaceae	*Cissampelos capensis* L.f.	Root infusion used for wounds and skin diseases (Kambizi 2016)	
Ochnaceae	*Ochna holstii* Engl.	Shoots are mixed with water and animals are allowed to drink 1 l for eating problems in cattle (Luseba and Tshisikhawe 2013)	
Olacaceae	*Ximenia americana* L.	Leaves and branches are boiled for 1 h and 1 l is given once a day for 3 days for wounds (Luseba and Tshisikhawe 2013). Aerial parts are ground and mixed with water and 1 l is given to cows for calving difficulties (Luseba and Tshisikhawe 2013)	
Oleaceae	*Olea europaea* subsp. *africana* (Mill.) P.S.Green	Bark is crushed and soaked with warm and administered orally for black quarter (Mthi et al. 2018)	
Pedaliaceae	*Dicerocaryum eriocarpum* (Decne.) Abels	Aerial parts are ground and mixed with water and given to cattle in a 1 l bottle for worms (Luseba and Tshisikhawe 2013)	
Peraceae	*Clutia pulchella* L.	Leaves applied on skin for flea reduction in chickens (Moyo and Masika 2013)	Antibacterial, anti-inflammatory and genotoxicity (Madikizela et al. 2012)

Pittosporaceae	*Pittosporum viridiflorum* Sims	Bark infusion used for intestinal parasites in goats (Maphosa and Masika 2010)	Antibacterial and cytotoxicity (Elisha et al. 2017)
Polygonaceae	*Rumex lanceolatus* Thunb.	Root decoction is used for intestinal parasites in goats (Maphosa and Masika 2010)	
Ptaeroxylaceae	*Ptaeroxylon obliquum* Thunb. Radlk.	Leaf decoction used to treat intestinal parasites in goats (Maphosa and Masika 2010)	
Rhamnaceae	*Ziziphus mucronata* Willd.	Leaf infusion used to treat intestinal parasites in goats (Maphosa and Masika 2010)	
Rosaceae	*Prunus persica* (L.) Batsch	Leaf infusion used to treat wounds in cattle (Kambizi 2016). Leaves and ground and juice squeezed and applied to wound or eyes (Luseba and Tshisikhawe 2013)	
Rubiaceae	*Cephalanthus natalensis* Oliv.	Leaves are ground with water and given to animal in 1 l bottle for eye problems (Luseba and Tshisikhawe 2013)	Antimycobacterial, anti-inflammatory and antioxidant (Aro et al. 2016)
	Coddia rudis (E.Mey. ex Harv.) Verdc.	Root infusion used to eliminate ticks (Kambizi 2016)	
	Hyperacanthus amoenus (Sims) Bridson	Fresh roots are crushed and juice is squeezed into the eye for eye problems (Luseba and Tshisikhawe 2013)	
	Rothmannia capensis Thunb.	Root decoction is administered in a 2 l bottle for eating problems in cattle (Luseba and Tshisikhawe 2013)	
Rutaceae	*Zanthoxylum capense* (Thunb.) Harv.	Root decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
Solanaceae	*Solanum incanum* L.	Fruits are ground and applied to the eyes to treat eye problems in goats, sheep and cattle; leaves are ground, mixed with water and given to the animal for eye problems (Luseba and Tshisikhawe 2013)	
Sterculiaceae	*Hermannia incana* Cav.	Decoction of whole plant used for intestinal parasites in goats (Maphosa and Masika 2010)	
Tiliaceae	*Grewia occidentalis* L.f.	Bark decoction used for intestinal parasites in goats (Maphosa and Masika 2010)	
Verbenaceae	*Lippia javanica* (Burm.f.) Spreng	Leaves are burnt to ash and smoke used to deter external parasites of chickens (Mwale and Masika 2009)	

Soyelu and Masika (2009). *Aloe ferox* is also reported to be used to treat ticks and mites by the farmers in Kwezi and Ntambethemba villages in the Eastern Cape Province (Sanhokwe et al. 2016).

In all the surveys mentioned, the most frequently used plant part was the leaves and the methods of preparation were mainly decoctions and infusions. Decoctions were the most frequently used method as this involves boiling the plant material in water to extract water soluble (polar) chemical compounds, and it could also detoxify poisonous plants depending on the type of toxins the plants contain (Maphosa and Masika 2010). Intestinal parasites were mentioned in most of the surveys, proving that they are a growing problem in most parts of the country. During the surveys, it was also found that some ethnic groups used a combination of two or more plant species during preparation to ensure that the treatment becomes effective, while other ethnic groups used single plant species (Luseba and Tshisikhawe 2013; Maphosa and Masika 2010; McGaw and Eloff 2008).

There is on some occasions a relationship between plants which are used for animal health care and plants which are used for human health care. *Hippobromus pauciflorus* (Sapindaceae) is used to treat diarrhoea in humans (Bisi-Johnson et al. 2010) while it is also used to wash wounds in animals (Soyelu and Masika 2009). The Vhembe community uses *Turraea obtustfolia* (Meliaceae) to treat wounds in animals by directly applying it on the wound (Luseba and Tshisikhawe 2013) while it is also used by the people of Pondoland to treat diarrhoea (Madikizela et al. 2012). Some plants like *Ziziphus mucronata* (Rhamnaceae) and *Bulbine abyssinica* (Asphodelaceae) are used for similar ailments such as diarrhoea and gastro-intestinal parasites (McGaw and Eloff 2008; Maphosa and Masika 2010).

Antibacterial assays may be divided into three different assays namely agar diffusion, dilution, and bioautography but from 2008 to date most studies applied the serial microdilution assay described by Eloff (1998), which includes the determination of the minimum inhibitory concentration (MIC) values of extracts against different bacterial organisms (Dzoyem et al. 2014; Elisha et al. 2016; McGaw and Eloff 2010; Sserunkuma et al. 2017). Acetone is believed to be the most suitable solvent of choice for antibacterial testing as it was found to be nontoxic to different bacterial strains at the dilutions tested during the serial broth microdilution assay (McGaw and Eloff 2010). Dzoyem et al. (2014) demonstrated this where acetone extracts of *Crotalaria capensis* had high activity against *Salmonella typhimurium*, followed by *Indigofera cylindrica* with MICs of 20 µg/mL and 40 µg/mL.

Since ethnoveterinary practitioners mostly use water as a solvent, research has also turned to using water as an extraction solvent when performing laboratory in vivo assays to try and obtain the same results/activity obtained by the ethnoveterinary practitioners. In a study done by Kambizi (2016), *Harpephyllum caffrum* and *Coddia rudis* were both separately tested for their antibacterial activity. The bark of *Harpephyllum caffrum* and the leaves of *Coddia rudis* were separately air dried at room temperature and water was used as a solvent. *Harpephyllum caffrum* extracts inhibited both Gram-negative and Gram-positive bacterial strains at an MIC ranging from 0.5 to 1 mg/ml while *Coddia rudis* was active at a rather high concentration of 5 mg/ml for all bacterial strains. Excellent MIC values were observed for crude acetone extracts of the following plant species: *Maesa lanceolata* (0.02 mg/ml), *Bolusanthus speciosus, Hypericum roeperianum* and *Morus mesozygia* (0.04 mg/ml). These extracts were tested against *Bacillus anthracis* and showed promising antibacterial activity (Elisha et al. 2015). It was then suggested that *Maesa lanceolata* extracts could be used as a disinfectant and *Hypericum roeperianum* could also be used to protect animals against bacterial attack (Elisha et al. 2016).

A number of the plants documented in this study were also documented in the study of McGaw and Eloff (2008). Twenty-eight plants out of the total 83 (comprising 34%) documented in the past 10 years had already been recorded previously and in many cases this was for similar ailments. However, some of the plant species were found to be used for different ailments. According to Maphosa and Masika (2010) *Gunnera perpensa* is used by farmers of the Eastern Cape Province to treat intestinal parasites in goats while the same plant is used by both animals and woman for expulsion of afterbirth (Gerstner 1939). Luseba and Tshisikhawe (2013) recorded that the farmers of the Vhembe region in the Limpopo Province use *Ximenia americana* to treat wounds and calving difficulties while Van der Merwe et al. (2001) documented use of the same plant for intestinal parasites. Hutchings et al. (1996) also stated that *Ptaeroxylon obliquum* is used as an anthrax remedy and against ticks in cattle while Maphosa and Masika (2010) report that it is also used for intestinal parasites in goats.

10.5 Conclusion

Based on all the surveys mentioned, it can be concluded that the most frequently used plant part was the leaves and the common methods of preparation were decoctions and infusions. Decoctions were the most frequently used method as this involves boiling the plant material in water to extract water-soluble (polar) chemical compounds, and it could also detoxify poisonous plants depending on the type of toxins the plant contains (Maphosa and Masika 2010). Intestinal parasites were mentioned in most of the surveys, proving that they are a growing problem in most parts of the country. During the surveys, it was also found that some ethnic groups used a combination of two or more plant species during preparation to ensure that the treatment becomes effective, while other ethnic groups used single plant species (Luseba and Tshisikhawe 2013; Maphosa and Masika 2010; McGaw and Eloff 2008).

Relatively, few surveys specific to ethnoveterinary medicine were identified from 2008 to 2018 in South Africa. Out of these surveys, most were conducted in the Eastern Cape Province and a few in Venda, Limpopo. This shows that only two provinces out of a total of nine in South Africa have been investigated for ethnoveterinary practices over the past 10 years. Of all the identified plants, only few species were subsequently investigated for potential relevant biological activity. Hence, more research needs to be done on both ethnoveterinary field studies amongst different ethnic groups around South Africa, as well as pharmacological activity and toxicity investigations of ethnoveterinary remedies.

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Chapter 11
Ethnoveterinary Plants and Practices for the Control of Ticks and Tick-Borne Diseases in South Africa

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Keywords Medicinal plants · Ethnoveterinary medicine · Ticks · South Africa

11.1 Economic Importance of Ticks

Livestock production in South Africa is a significant contributor to food security and clothing, and provides many social and economic attributes to the country. It is estimated that two-thirds of resource-poor rural households keep some type of livestock. Poor urban households, even in large cities, also own livestock (Meissner et al. 2013). While these farmers face many constraints in their farming activities, the most important limiting factor to the productivity of their animals is the prevalence of ticks and the diseases they carry. The latter is particularly important in the wet season as the warm climate of the tropics and sub-tropics enables many species of ticks to flourish, while the large populations of indigenous wild animals also provide a constant reservoir for ticks and infectious organisms (Jongejan & Uilenberg 2004).

Ticks are the most economically important ectoparasites of domestic animals and man (Mans et al. 2000). They are hematophagous arthropods ranked close to mosquitoes in their capacity to transmit important diseases (viral, bacterial, rickettsial and protozoal), which can be severely debilitating or fatal (Jongejan and Uilenberg 2004). Ixodids (hard ticks) such as *Amblyomma, Hyalomma* and

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Rhipicephalus species and argasids (soft ticks) such as *Argas persicus*, the most important poultry parasite, are among the most economically important parasites in the tropics and subtropics (Rajput et al. 2006). It is estimated that the global economic burden due to ticks and tick-borne diseases on animal health ranges from US$ 13.9 to 18.7 billion annually (De Castro et al. 1997). In Africa, tick-borne diseases kill nearly 1.1 million cattle annually with resultant economic losses of US$168 million (Minjauw and McLeod 2003).

11.2 Direct Economic Losses Due to Ticks

11.2.1 Biting Stress and Loss of Production

All feedings of ticks at each stage of the life cycle are parasitic. During the feeding process, ticks attach to the skin of their host with their mouthparts. Pruritus (itching) due to the release of histamine from mast cells and pain (caused by bradykinin release) at the numerous feeding sites on the host's skin results in general decrease in food intake (anorexia) of affected animals with resultant weight loss, poor growth and losses in milk production. Other effects include chronic blood loss (anaemia), which over time also contributes to weight loss and poor production from a number of contributing factors of which the main one is from the loss of nutrients to a significant number of ticks (Jonsson 2006).

11.2.2 Physical Damage

Despite their differing sizes, larval, nymphal and adult mouthparts of argasids and ixodids penetrate to a similar depth towards the base of the Malpighian layer of the skin and this may occur within 5 min of the arrival of the tick on the host, causing open wounds (Jones et al. 2015). The skin attempts to repair itself through an orchestrated cascade of biochemical events: haemostasis, inflammation, tissue proliferation and tissue remodelling. These events produce scars at several feeding sites that remain for years, long after the ticks have detached. When skins of these livestock are made into leather, these scars remain as blemishes that reduce the value of the leather.

11.2.3 Wound Infection

The process of tick feeding also results in secondary wound infections with opportunistic bacteria (such as *Staphylococcus aureus*) and fungi (such as *Aspergillus fumigatus)* on the skin. The wound site is also susceptible to infestation with larvae of parasitic flies causing myiasis – the infestation of the body of a live vertebrate animal by larvae of flies that grow inside the host while feeding on its tissue. The adult females of parasitic flies lay their eggs on the animal, and these hatch in approximately 8–24 h, depending on the environmental conditions. Once hatched, the larvae tunnel through wounds into the host's subcutaneous tissue. Painful, slow-developing ulcers or furuncle (boil) like sores occur. After about 24 h, bacterial infection is likely and, if left untreated, could lead to septicaemia (bacteria in the blood), which may be fatal (Mukandiwa et al. 2012). *Cordylobia anthropophaga* (tumbu fly) has been endemic in the subtropics of Africa for more than 135 years (Adisa and Mbanaso 2004).

11.2.4 Poisoning by Ticks

Tick paralysis, a major form of tick toxicosis in animals, is caused by the adult female tick during the period of rapid engorgement (days 5–7), although large numbers of larval or nymphal ticks may also cause paralysis. More than 60 species of ticks have been implicated so far to induce tick paralysis. The most noted and dangerous tick in this respect in South Africa is the Karoo paralysis tick (*Ixodes rubicundus*). The adult tick excretes a toxin that causes paralysis in sheep, goats and cattle. The paralysis commonly occurs from February and reaches a peak in April and May. Sudden drops in temperature caused by rain, cold winds and cloudy conditions seem to stimulate the activity of the adult ticks. Affected animals become paralysed and some may show signs of uncoordination and stumbling. Unless ticks are removed, the animal remains paralysed and dies within days (Durden and Mans 2016). The feeding of the cattle leg tick, *Rhipicephalus praetextatus,* also causes toxicosis in cattle in Africa, resulting in paralysis.

11.3 Indirect Economic Losses Due to Ticks

In addition to causing direct losses, ticks are vectors of numerous, economically important diseases of livestock and humans and as such are key targets for infection control.

11.3.1 Viral Diseases

11.3.1.1 African Swine Fever (ASF)

African swine fever virus, the causative agent of ASF, is the only member of the Asfarviridae family and the only virus with a double-stranded deoxyribonucleic acid genome transmitted by arthropods that replicates in the cytoplasm of infected cells (Rowlands et al. 2008). It is endemic to sub-Saharan Africa and exists in the wild through a cycle of infection between ticks and wild pigs, bush pigs and warthogs (Denis 2014).The ASF virus is transmitted in domestic pigs by the feeding of *Ornithodoros moubata* ticks.

In South Africa, reports of ASF date back to as early as 1926 when it was first recorded in the northern parts of the country, formerly known as Transvaal (Boshoff et al. 2007). In 1935, South Africa instituted and gazetted a designated ASF control area that mainly encompasses the Limpopo Province, the northern parts of North West and KwaZulu-Natal provinces and the northeastern parts of Mpumalanga Province (Fig. 11.1). The designation of the area was based on the presence of

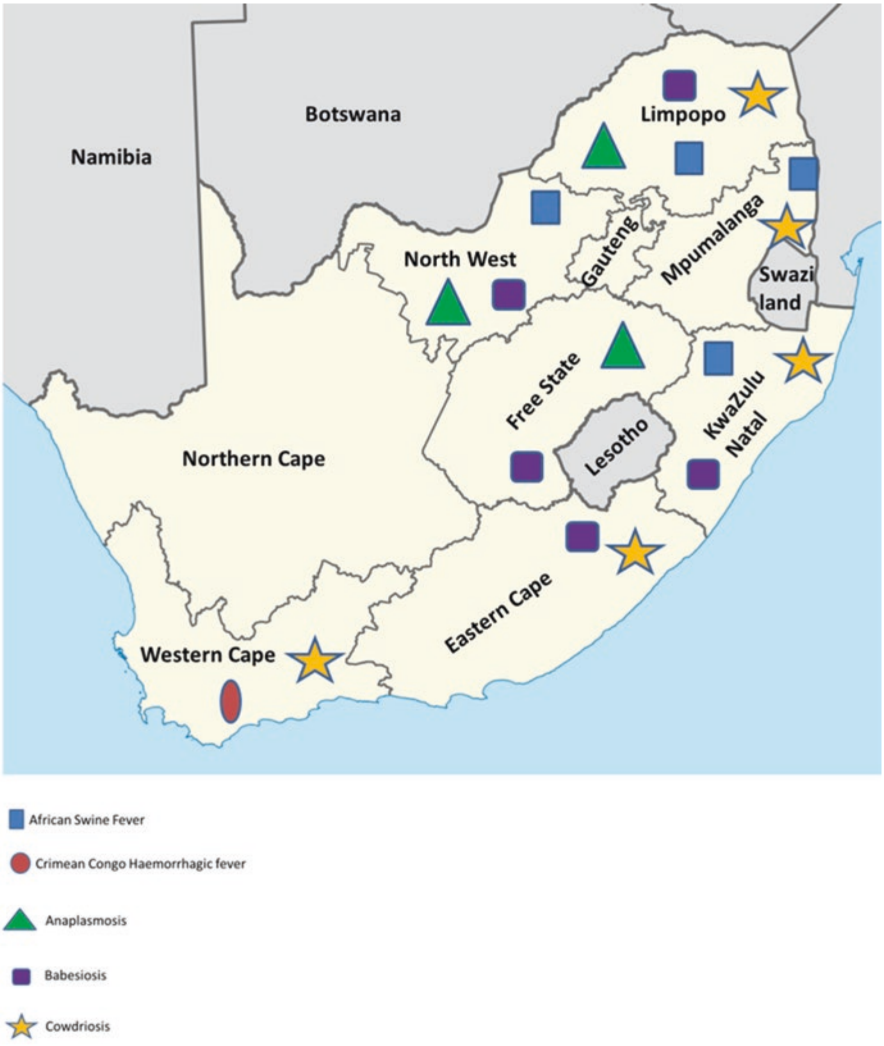

Fig. 11.1 Distribution of economically important tick-borne diseases in South Africa

epidemiologically significant factors (host, environmental and etiologic agent factors) and the presence of outbreaks. The last reported outbreak in Mpumalanga occurred in 1951. In 1996, an outbreak was reported just outside the control area in Bela-Bela, Limpopo Province (Penrith 2009). In 2012, confirmed cases of ASF were reported in Gauteng (Penrith 2013).

The acute form of the disease (transmitted by highly virulent strains) is highly contagious and causes high mortality in pigs. Pigs may develop a high fever, but show no other noticeable symptoms for the first few days. They then gradually lose their appetite and become depressed. In white-skinned pigs, the extremities turn bluish-purple and haemorrhages become apparent on the ears and abdomen. Groups of infected pigs lie huddled together, shivering, breathing abnormally and sometimes coughing. Within a few days post-infection, they enter a comatose state and die. In pregnant sows, spontaneous abortions occur and in milder infections, affected pigs lose weight and develop signs of pneumonia, skin ulcers and swollen joints (Howey et al. 2013).

11.3.1.2 Crimean-Congo Haemorrhagic Fever (CCHF)

Crimean-Congo haemorrhagic fever is caused by a virus of the Bunyaviridae family a medically important, endemic tick-borne pathogen in South Africa (Ince et al. 2014). The first outbreak of the disease was described in 1944 in the Crimean peninsula, Eastern Europe, in people bitten by ticks while harvesting crops and sleeping outdoors (Capua 1998). The virus is typically transmitted by the so-called "bont poot" ticks, *Hyalomma rufipes* and *H. truncatum.* The pathogen is geographically aligned to the distribution of the tick vector, and occurs in the more arid parts of South Africa, particularly on the inland plateau. *Hyalomma* ticks feed on a variety of domestic ruminants (sheep, goats and cattle) as well as wild herbivores, hares, hedgehogs and certain rodents. Although CCHF virus infection in animals is generally subclinical (ostriches are however susceptible), it generates viremia levels capable of supporting virus transmission to uninfected ticks (Ince et al. 2014). The disease is zoonotic and while clinical disease is rare in infected animals, it is severe in infected humans with a mortality rate of 10–50% (Fajs et al. 2014).

The CCHF virus, which was unrecognised in South Africa before 1981, now appears to be widespread in animal reservoirs throughout most parts of the country (Sharifi-Mood et al. 2014). Thus, there is a large susceptible population and the risk of infection exists for livestock workers, veterinarians and other people who live or work in rural environments (Sharifi-Mood et al. 2014). In a study, 17 cases of CCHF were reported and all of them were workers in ostrich slaughterhouses in the Oudtshoorn district, Western Cape, South Africa (Capua 1998) (Fig. 11.1).

Typically, 1–3 days following a tick bite or 5–6 days after exposure to infected materials, flu-like symptoms, haemorrhage progressing to respiratory distress, kidney failure and shock occur. Patients usually begin to show signs of recovery 9–10 days post-infection. However, 30% of cases result in death during the second week of illness (Bente et al. 2013).

11.3.2 Bacterial and Rickettsial Diseases

11.3.2.1 Borreliosis (Lyme Disease)

Borreliosis is transmitted to domestic animals and humans from a natural reservoir among small mammals and birds by *Ixodes* ticks. The incidence and geographical spread of borreliosis is increasing and current serological and clinical evidence indicates that borreliosis has a worldwide distribution in humans, domestic and wild mammals and birds. The disease is endemic in northern Europe and the United States of America (Strijdom and Berk 1996) and the causative agents identified are *Borrelia afzelli, Borrelia burgdorferi* sensu stricto and *Borrelia mayonii* respectively (Shapiro 2014). The incidence of borreliosis in South Africa is unknown. The country has a wide variety of tick species that include five tick genera in which spirochaetes have been found elsewhere in the world. Although ticks of the *Ixodes* family are uncommon in South Africa, *B. burgdorferi* is reported to have been isolated from mosquitoes (Adebajo et al. 1994).

11.3.2.2 Anaplasmosis (Tick-Borne Fever, Gall Sickness)

Anaplasmosis is a disease of ruminants caused by obligate, intraerythrocytic bacteria of the order Rickettsiales, family Anaplasmataceae and genus *Anaplasma.* This includes *Anaplasma phagocytophilum, Anaplasma marginale, Anaplasma centrale, Anaplasma equi*, *Anaplasma bovis*, *Anaplasma ovis* and *Anaplasma platys.* Bovine anaplasmosis has been endemic in South Africa (Fig. 11.1) and 99% of the total cattle population is at risk of acquiring *Anaplasma marginale* infection (Mutshembele et al. 2014). Five tick species have been shown experimentally to transmit *Anaplasma marginale* in South Africa, including *Rhipicephalus microplus*, *R. decoloratus*, *R. evertsi evertsi*, *R. simus*, and *Hyalomma marginatum rufipes* (de Waal 2000). Although the term “anaplasmosis” is often associated with animal infection, the disease also occurs in humans (Hartelt et al. 2004).

This disease is characterised by progressive anaemia due to extravascular destruction of infected and uninfected red blood cells. Animals with peracute infections die within a few hours of the onset of clinical signs. Acutely infected animals are anaemic and lose condition rapidly, milk production falls, and inappetence and loss of coordination are common signs. Breathlessness upon exertion occurs, and a rapid pulse is usually evident in the late stages. Pregnant cows may abort and surviving cattle convalesce over several weeks, during which time haematologic parameters gradually return to normal (Lew-Tabor and Valle 2015). The animals that recover from the disease become persistently infected and serve as a reservoir of infection for mechanical and biological transmission by ticks (Kocan et al. 2003).

11.3.2.3 Cowdriosis (Heartwater)

The disease was known in South Africa for nearly 90 years before the causative organism was identified in 1925 as a rickettsia, originally named *Rickettsia ruminantium* (Cowdry 1925). The name was later changed to *Cowdria ruminantium*, from which arose the term 'cowdriosis' (Moshkovski 1947). Molecular phylogenetic studies of the Rickettsiales in the 1990s uncovered the real evolutionary relationships within the order and the organism was reclassified as *Ehrlichia ruminantium* in the family Anaplasmataceae (Allsopp 2015). *Ehrlichia ruminantium*, an obligately intracellular organism, which is transmitted by *Amblyomma hebraeum* ticks, is endemic in South Africa (Stotlsz 2005) (Fig. 11.1). It infects cattle, sheep, goats and some wild ruminants, and the disease is frequently fatal (Plans and Plan 2016). It is estimated that mortality due to cowdriosis is more than twice that due to babesiosis and anaplasmosis combined (Plans and Plan 2016).

The common name of the disease, "heartwater", is derived from fluid that accumulates around the heart or in the lungs of infected animals. In peracute cases, animals may drop dead within a few hours of developing a fever, sometimes without any apparent clinical signs; others display dyspnea (laboured breathing) and/or paroxysmal convulsions. In the acute form, animals often show anorexia and depression along with congested and friable mucous membranes. Dyspnea slowly develops and nervous signs such as hyperesthesia, a high-stepping stiff gait, exaggerated blinking and chewing movements. Terminally, prostration with bouts of opisthotonus (pedaling and stiffening of the limbs) and convulsions are seen. In subacute cases, the signs are less marked and the involvement of the central nervous system is inconsistent (Plans and Plan 2016).

11.3.2.4 Ehrlichiosis (Tropical Canine Pancytopenia, Canine Rickettsiosis, Canine Hemorrhagic Fever, Canine Typhus, Tracker Dog Disease)

Ehrlichia canis is a rickettsial bacteria belonging to the family Ehrlichiaceae and is transmitted by *R. sanguineus.* It causes ehrlichiosis, a disease of dogs, although humans, goats and cats can also become infected after exposure to ticks (Loftis et al. 2008). The disease was first described in South Africa in 1938 (Geromichalou and Faixová 2017). Serological surveys have shown that dogs with antibodies reactive with *E. canis* by indirect immunofluorescence assays can be found in 42% of dogs in South Africa (Inokuma et al. 2005).

There are three stages of canine ehrlichiosis, each varying in severity. The acute stage, occurring several weeks post-infection and lasting for up to 1 month, can lead to fever and bone marrow suppression with resultant pancytopenia (lowered peripheral blood cell counts). The second stage (subclinical phase), has no apparent clinical signs and can last through the animal's life-time, during which the animal remains infected with the organism. Some are however able to successfully eliminate the disease during this time. In some however, the third and most serious stage of infection, the chronic phase, will commence. Pancytopenia, bleeding, lameness, neurological degeneration, ophthalmic disorders and kidney failure may result. Clinical signs of human ehrlichiosis include fever, headache, eye pain and gastrointestinal upset (Reeves et al. 2008).

11.3.3 Protozoal Diseases

11.3.3.1 Babesiosis (Redwater, Texas Cattle Fever, Piroplasmosis)

Babesiosis is the cause of serious economic losses in South Africa and involves most areas with an annual rainfall of more than 400 mm (De Vos 1979) (Fig. 11.1). The causative agent is *Babesia*, the second most common haemoparasite of mammals, after *Trypanosoma.* Ticks, especially *R. (B.) microplus, R. sanguineus, R. (B.) decoloratus* and *I. scapularis* transmit several *Babesia* species to cattle (*Babesia bovis, Babesia bigemina*); horses (*Babesia equi, Babesia caballi);* dogs (*Babesia canis*); cats (*Babesia felis, Babesia cati*) and humans (*Babesia microti, Babesia duncani*, *Babesia divergens, Babesia venatorum*) (Gray et al. 2010).

Clinical signs in domestic animals include fever, anorexia, haemolytic anaemia, muscle pain, vomiting, weight loss, enlarged liver, icterus (yellowing of the mucous membrane); general organ failure and death may ensue (Shaw and Day 2005).

11.3.3.2 Theilerioses

This refers to a group of diseases caused by *Theileria* in domestic and wild animals in tick-infested areas. East Coast fever, an acute disease of cattle, is caused by *Theileria parva* and transmitted by the tick, *R. appendiculatus.* It is a serious problem in east and southern Africa. The African buffalo (*Syncerus caffer*) is an important reservoir of the pathogen, although infection is asymptomatic. The disease is characterised by fever, which occurs 7–10 days post-infection and panlymphadenopathy (generalised swelling of the lymph nodes). Anorexia develops and the animal rapidly loses condition, lacrimation (abnormal secretion of tears) and nasal discharge may occur. Terminally, dyspnea is common, and death usually occurs 18–24 days post-infection (Katzer et al. 2010).

Theileria annulata, the causative agent of tropical theileriosis, transmitted by *Hyalomma* ticks, is widely distributed in north Africa, the Mediterranean coastal area, the Middle East, India and Asia. It can cause mortality of up to 90%, but strains vary in their pathogenicity. The kinetics of infection and the main clinical findings are like those of *Theileria parva*, but anaemia is often a feature of the disease (Sayin et al. 2003).

Theileria lestoquardi (previously known as *Theileria hirci*) causes a disease in sheep and goats like that produced in cattle by *Theileria annulata*, with which it is closely related. *Theileria equi* in horses causes equine piroplasmosis and *Theileria* *lewenshuni* and *Theileria uilenbergi*, transmitted by *Haemaphysalis* ticks, have been identified as the causative agents of a severe disease in sheep in China (Englund and Pringle2004).

11.4 Tick Control

Tick control programmes are largely based on the use of commercially available chemicals such as the arsenicals, organochlorines, phenylpyrazoles, organophosphates, carbamates, formamidines, pyrethroids, macrocyclic lactones and more recently, the spinosyns, insect growth regulators and isoxazolines on/in the animals or in the environment (Gassel et al. 2014; Adenubi et al. 2018). Several active ingredients with acaricidal and/or tick repellent effects are commercially available for use on companion animals, livestock and humans. These are prescribed in different formulations, including tablets, sprays, soaps, shampoos, powders, impregnated collars, dip solutions, pour-on and spot-on applications. The global parasiticide market was valued at US$ 6509 million in 2013. This is expected to reach US$8918 million by 2019, growing at a rate of 5.4% (www.marketsandmarkets.com). In 2013, Africa accounted for 2.7% of the global parasiticide market, which was valued at US$173.8 million. Of this, ectoparasiticides accounted for 60.1% (US$96.2 million) and this is expected to reach US$137.9 million, growing at a rate of 6.3% by 2019 (www.marketsandmarkets.com).

Commercial acaricides are expensive and not easily accessible to rural farmers. In addition, toxicity due to overdosing, resistance due to underdosing and misuse as well as food and environmental contamination has been reported (Panella et al. 2005). This has led to the search for safe and environmentally-friendly alternatives and a number of unconventional tick control approaches have been advocated (Mondal et al. 2013). These measures are directed towards averting production losses, dropping tick numbers to minimal levels, decreasing chemical residue risks and reducing the dependence on chemicals (Ghosh et al. 2007). Such methods include pasture spelling (Manjunathachar et al. 2014), vaccination (de la Feunte and Kocan 2014), biological control (Nana et al. 2015; Nana et al. 2016), genetic manipulation (Kocan et al. 2003) and the use of ethnoveterinary practices with herbal remedies at the core of therapy (Adenubi et al. 2016, 2018).

11.5 Ethnoveterinary Medicine

Rural and semi-urban farmers have limited access to veterinary care, information about animal diseases, therapeutic veterinary medicines and vaccines and therefore have to rely heavily on ethnoveterinary medicine in most cases. Ethnoveterinary medicine refers to the holistic, interdisciplinary study of indigenous knowledge and its associated skills, practices, beliefs, practitioners and social structures pertaining to the healthcare and husbandry of food, work and other income-producing animals.

The goal is to increase human wellbeing via increased benefits from stock-raising (Martin et al. 2001; Van der Merwe et al. 2001). While the use of ethnoveterinary medicine is common practice in rural farming areas, it is often questioned for its inherent safety and efficacy by the Western world as the use has developed through trial and error and only rarely via deliberate experimentation for the development of modern pharmaceuticals (Katerere and Naidoo 2010). Hence, ethnoveterinary medicine has been viewed as less systematic, less formalised and at times even questioned for its validity. Nonetheless, there is a growing acceptance that ethnoveterinary medicine has therapeutic value and needs further evaluation not only to justify its use, but also as a potential source of newer medications to combat multi-resistant pests and disease organisms (Lans et al. 2007a, b).

Ethnoveterinary medicine plays an important role in the animal health care system in South Africa (Mathias-Mundy and McCorkle 1995). Rural and semi-urban farmers have indigenous practices to treat ticks and tick-borne diseases using medicinal plant species, manipulative techniques, herd management and socio-cultural procedures. These practices are perceived as simple, cost-effective, environment friendly, contextually appropriate and culture-based (Kolawole et al. 2007). The modality involved in the production of herbal medicines varies according to the active ingredients to be extracted, the route of administration and the medical intent (prophylaxis or therapeutics). Livestock owners and herders prepare infusions, decoctions, powders, drops, fumes, pastes and ointments from medicinal plants, animal, mineral and other natural substances. These could be administered topically, as drenches, suppositories, or through smoke and vapours intra-nasally.

There are several threats undermining the relevance of ethnoveterinary medicine in contemporary African societies. These include ecological and technological changes, access to modern health facilities, anthropogenic and natural factors that threaten the existence of many plant species of veterinary importance (Yineger et al. 2008). Because the mode of transfer and documentation of indigenous veterinary knowledge has been, and is still, oral and apprenticeship specific, partial or total loss of accumulated medical heritage is likely (Yineger et al. 2008). Rapid socio-economic and outward rural migrations and paucity of research on ethnoveterinary uses of medicinal plants in treating livestock diseases further undermines its relevance (Maphosa and Masika 2010). We provide information from selected studies that include ethnoveterinary plants and practices, used in traditional veterinary medicine in South Africa for tick infestation as repellents or acaricides. We believe that this may be useful to researchers working on plants as potential tick control agents.

11.5.1 Traditional Tick Control Methods in South Africa

Masika et al. (1997), Luseba and Van der Merwe (2006) and Moyo and Masika (2009) reported several alternative tick control methods such as chickens pecking on livestock, topical application of used engine oil, manual removal by cutting and pulling the ticks, Jeyes fluid and the use of medicinal plants.

Domestic chickens remove ticks from recumbent livestock in the morning hours as well as ingesting engorged adult ticks that have dropped off to the ground. There have been proposals that chickens be incorporated into integrated tick control programmes for livestock in rural villages in South Africa, on the condition that chicken-friendly acaricides are used (Moyo and Masika 2009). However, the use of chickens cannot be a major control method because their consumption rate is minimal, and some farmers do not have enough chickens to feed on ticks.

Used engine oil is said to be effective in controlling cattle ticks (Masika et al. 1997), however its safety to animals and meat consumers has not been assessed. Toxic components in used engine oil, such as lead, chromium, copper and zinc, can contaminate some plants and the environment (Delistraty and Stone 2007). The components may also become concentrated in animal by-products consumed by humans and may be toxic to them. Many rural farmers depend on government pensions and cannot afford to buy conventional acaricides. They resort to using used engine oil to control ticks on their cattle. However, the use of engine oil is not a practice that should be promoted.

Jeyes fluid is a commercial product, used as a household disinfectant. It contains mainly tar acids – 13% m/m carbolic acid – and sodium hydroxide (1%). The use of Jeyes fluid as an acaricide probably dates back to the use of carbolic dip for tick control more than 50 years ago (Moyo and Masika 2009). Jeyes fluid is a corrosive product that has the potential to cause adverse effects on the skin and eyes. With prolonged and repeated skin contact, it may result in irritation, skin dermatitis, blisters and burns (Moyo and Masika 2009). The safety of Jeyes fluid to animals and the environment, together with its residual effect to consumers, is not known and therefore caution needs to be taken when using it or its use needs to be discouraged.

Manual removal of ticks is widely practiced in smallholder farming systems in South Africa. Masika et al. (1997) reported that 10% of livestock owners in the central region of the Eastern Cape Province of South Africa either cut ticks off with blades, scissors or pulled them from their animals. Manual removal of ticks could be an alternative to complement the main tick control method. However, it is laborious and pulling off the ticks damages the animal tissues, especially for ticks with long mouth parts.

11.5.2 Use of Medicinal Plants

South Africa boasts a unique and diverse botanical heritage with over 30,000 plant species of which about 3000 are used therapeutically (Steenkamp and Smith 2006). In addition to this unique botanical heritage, South Africa has a cultural diversity with traditional healing being integral to each ethnic group. Farmers use different parts of some medicinal plants against livestock ticks and tick-borne diseases (Table 11.1).

Table 11.1. Plant species used for tick control in South Africa

Plant family	Plant species	Common name (English)	Vernacular names	Plant part used and preparation	Distribution	Results of reported acaricidal/ tick repellent assays	References
Asphodelaceae	*Aloe ferox* Mill.	Bitter aloe	Bitteraalwyn (Afrikaans)	Fresh leaves are crushed, soaked in water overnight, strained and the mixture sprayed on cattle	Western Cape Eastern Cape southern KwaZulu-Natal, south-eastern part of the Free State	The crude extracts showed weak activity to *R. appendiculatus* species	Mawela (2008)[a]
		Red aloe	Inlaba (IsiZulu) Ikhala (IsiXhosa)				Moyo et al. (2009)[b]
Asteraceae	*Helichrysum* species	Everlasting	Kooigoed (Afrikaans) Imphepho (IsiXhosa, IsiZulu)	The plant burnt to ash and the smoke repels ticks. The ash is also placed in the incubators of incubating hens	Limpopo	NR	Mwale and Masika (2009)[b]
					Mpumalanga KwaZulu-Natal Free State Eastern Cape Western Cape		
Asteraceae	*Tagetes minuta* L.	Khaki bush Khaki weed African marigold	Unukayo (IsiXhosa)	Fresh leaves are crushed, soaked in water overnight, strained and the mixture sprayed on cattle	Eastern Cape	*Hyalomma rufipes* adults exhibited a significant dose-repellent response to the essential oil of *T. minuta*. The oil also significantly delayed moulting of 60% of nymphs after 25 days	Moyo et al. (2009)[b]

							Nchu et al. (2012)[a]
Rutaceae	*Ptaeroxylon obliquum* (Thunb.) Radik.	Sneezewood	Nieshout (Afrikaans)	Fresh leaves are crushed, soaked in water overnight, strained and the mixture sprayed on cattle	Eastern Cape	400 mg/ml repelled ticks (100%) for 40 min post-treatment	Moyo et al. (2009)[b]
			umThathi (IsiXhosa)				Moyo and Masika (2013)[a]
Verbenaceae	*Lippia javanica* (Burm.f.) Spreng	Fever tea Lemon bush	Inzinzinibz (IsiXhosa)	The whole plant is burnt to ash and the smoke repels ticks	Eastern Cape	The aqueous leaf extracts of *L. javanica* was effective at controlling cattle ticks at 10% and 20% w/v	Madzimure et al. (2011)[a]
			Umsuzwane	Ticks are sprayed with crushed leaves mixed with water or twigs are used as bedding in fowl runs	Kwazulu-Natal	Acetone extract of *L. javanica* afforded a sustained repellent activity over time (90%)	York et al. (2011)[c]
			Umswasi (IsiZulu)				Maroyi (2017)[b]

NR none reported
[a]Reference for reported acaricidal/tick repellent studies
[b]Reference for ethnoveterinary usage
[c]Reference for vernacular names/distribution

11.6 Conclusions

The South African middle-class population has increased dramatically in the last 10 years with concomitant growth in demand for livestock foods (Meissner et al. 2013). Livestock farming thus plays an enormous role in providing sustenance to these people as well as poor communities and stabilising the economies of towns in non-metropolitan areas. It becomes imperative that pests such as ticks, which have major impacts on animal health, be effectively controlled.

The efficacy of ethnoveterinary plants and practices for preventing and treating ticks and tick-borne diseases and range management strategies identified in this study needs to be fully investigated and potentially integrated into veterinary extension services. It is important that livestock farmers share ideas on traditional knowledge with veterinarians to optimise productive capacity of herds and enhance sustainable rural livelihoods.

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Chapter 12
Ethnoveterinary Medicine: A Zimbabwean Perspective

Prosper Jambwa and Emmanuel Tendai Nyahangare

Keywords Ethnoveterinary medicine · Zimbabwe · Research and development · Challenges · Poultry · Cattle · Goats

12.1 Introduction

The use of complementary medicine for the treatment of animals is still a common practice in many communal areas in Zimbabwe despite the advent of modern conventional drugs. Most rural folks have assimilated substantial traditional veterinary knowledge essential for animal health care (Gelfand et al. 1985). This knowledge is applied in livestock ethnoveterinary medicine in the country. Livestock is regarded as a measure of wealth in these communal set ups and therefore the rearing of animals plays an important role in people's livelihoods. The different types of livestock kept by Zimbabwean communal farmers include large ruminants (cattle and donkeys), small ruminants (goats and sheep) and non-ruminants (poultry, pigs, rabbits and guinea pigs). Cattle and donkeys play an important role as they are used for draught power in subsistence crop production. The other animal species are kept as a source of meat and are the main sources of protein for the rural communities. In this review, we focus on the most common livestock species kept by farmers, i.e., poultry, cattle and goats.

Although the Zimbabwean government has established Veterinary Departments in all the ten provinces, most communal farmers cannot afford to buy the drugs recommended by veterinary officers and usually rely on non-conventional medicine to treat their animals. In a survey conducted in seven administrative districts of Masvingo Province, all the respondents cited high costs of veterinary medicines as a great hindrance to livestock health management (Mudzengi et al. 2014). In addition, Veterinary Officers are also not able to cover the entire breadth of the country

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because of geographical challenges, and therefore farmers in the most remote areas do not sometimes even have access to professional veterinary expertise. This makes alternative medicine an integral part of livestock production in rural communities as the vast majority of the farmers seek low cost traditional medicines (Mwale et al. 2005; Maroyi 2012).

12.2 Application of Complementary Medicine in Poultry

Poultry is an important source of protein for both the urban and rural population of Zimbabwe. The urban people rely on commercial poultry producers who supply live birds, poultry meat and products whilst most rural households keep poultry native to their areas mostly for own consumption. Indigenous chickens, in particular, are an integral part of the marginalised rural set up although other poultry species are also kept in other communities (Masimba et al. 2011).

A plethora of diseases and health constraints are faced by farmers in poultry rearing, and perhaps the effects are worse for the smallholder communal farmer with few resources. Globally, in intensive commercial poultry production conventional drugs are used for therapy, prophylaxis, metaphylaxis and growth promotion whilst the Zimbabwean subsistence farmer uses ethnoveterinary medicines mostly for therapeutic purposes after noticing some symptoms (Masimba et al. 2011). The ethnoveterinary interventions are typically in the form of plant preparations although other remedies such as soot are also applied. In most instances, the farmers do not consult veterinary experts before administering the non-conventional therapies. The common health problems identified by rural farmers are mainly coccidiosis, Newcastle Disease, diarrhoea, wounds, respiratory diseases and egg laying problems (Masimba et al. 2011; Gumbochuma et al. 2013).

12.3 Ethnoveterinary Interventions Used in Poultry Production

Most of the interventions are mentioned in surveys and to date only a few experiments have been done to test for efficacy in scientific experiments in vitro and in vivo. Some of the surveys were not animal species specific, thus risking masking some ethnomedicinal interventions used for treatment of poultry. The surveys carried out by Masimba et al. (2011) and Mwale et al. (2005) were done in Gutu and Mushagashe areas respectively in Masvingo Province, and this shows that wider surveys involving other areas in different agricultural zones would produce an even richer database of ethno remedies. The documentation of traditional methods used for the treatment of animals is of paramount importance because there is a strong possibility that the knowledge may be lost as the older generation who are conversant in these methods is passing on.

Aloe species are the most commonly used plants for the ethnotreatment of poultry as they have been cited in all the surveys carried out in different settings in Zimbabwe (Mwale et al. 2005; Masimba et al. 2011; Maroyi 2012; Gumbochuma et al. 2013). There are many aloe species in Zimbabwe and most of these species have medicinal uses. However, the use of only five species (*Aloe chabaudii, Aloe excelsa, Aloe greatheadii, Aloe spicata* and *Aloe vera*), has been documented through ethnosurveys as being useful regimens in the treatment of poultry. It is highly likely that the other aloe species found in Zimbabwe are also used for the traditional treatment of poultry, as other authors did not identify the *Aloe* species from their surveys. Aloe remedies are used for a broad spectrum of poultry ailments including wounds, respiratory and gastrointestinal problems. They are also used as an intervention against ectoparasites. Other plant species used for the ethnoveterinary treatment of poultry in Zimbabwe and common ailments affecting chickens in communal areas and the number of plant species cited as remedies in Zimbabwe are shown in Table 12.1 and Fig. 12.1.

The highest number of plant species are used as interventions to treat coccidiosis in infected chickens whilst nervous disorders, jaundice and egg-laying problems have the least number of plant species with only one plant species cited as being used for each condition. Most of the ethnomedications given for the treatment of respiratory problems, coccidiosis and other gastrointestinal problems are prepared as infusions and administered orally in drinking water. Wound treatments involve the application of plant paste, sap or dried powder on the affected area of the birds whilst eradication of ectoparasites is achieved through sprinkling the birds with plant infusions.

12.4 Ethnoveterinary Practices in Cattle and Goats

Just like poultry, cattle also play a very important role for many farmers, the bulk of which are in rural communal areas in Zimbabwe. Not only are they a sign of wealth but they provide good nutrition (meat and milk), manure, draught power and are used in many traditional ceremonies. Goats are also very important in the livelihood matrix of the rural farmers. Poor health management has always been one of the impediments to optimal productivity to these livestock species often exacerbated by the harsh economic climate, prices of health remedies and access to conventional veterinary care of the animals. While synthetic products (medicines, acaricides and vaccines) dominate the market in the management of diseases and parasites, there are also ethnoveterinary products that have been used since time immemorial that some farmers are still using or have knowledge about. Plants contribute a significant chunk of the products that are used but there are also products that are not of plant origin. Some of the plant-based products that are used in Zimbabwe for control and treatment of animal parasites and diseases in cattle and goats are shown in Table 12.2.

Table 12.1 Selected ethnoveterinary interventions for poultry ailments

Botanical name	Family	Ethnomedicinal use: poultry diseases/ symptoms	Plant part	Nature of study	References
Adenium multiflorum	Apocynaceae	Diarrhoea	Bulb	Survey	Chavhunduka (1976)
		Sore eyes	Bulb		
Albizia gummifera	Fabaceae	Coccidiosis, respiratory problems, diarrhoea	Fruit	Surveys	Mwale et al. (2005); Masimba et al. (2011)
Albizia adianthifolia	Fabaceae	Coccidiosis	Bark	Surveys	Mwale et al. (2005); Gumbochuma et al. (2013)
		Wounds	Roots		
Allium cepa	Liliaceae	Diarrhoea, coccidiosis, respiratory problems	Bulb	Survey	Masimba et al. (2011)
		Lice	Bulb		
Allium sativum	Amaryllidaceae	Diarrhoea, coccidiosis	Bulb	Survey	Masimba et al. (2011)
		Lice	Bulb		
Aloe chabaudii	Asphodelaceae	Diarrhoea, respiratory problems, lethargy	Leaves	Survey	Maroyi (2012)
		Wounds	Leaves		
		Ectoparasites	Leaves		
Aloe excelsa	Asphodelaceae	Jaundice	Leaves	Survey	Chavhunduka (1976)
		Fowl pox	Leaves		
Aloe greatheadii	Asphodelaceae	Diarrhea, respiratory problems, lethargy	Leaves	Survey	Maroyi (2012)
		Wounds	Leaves		
		Ectoparasites	Leaves		
Aloe spicata	Asphodelaceae	Coccidiosis, Newcastle disease, fowl typhoid	Leaves	Survey	Mwale et al. (2005)
Aloe vera	Asphodelaceae	Coccidiosis, Newcastle disease, fowl typhoid, respiratory problems	Leaves	Survey	Mwale et al. (2005); Masimba et al. (2011)
Annona stenophylla	Annonaceae	Ectoparasites	Leaves	Survey	Chavhunduka (1976)
Capsicum annuum	Solanaceae	Diarrhoea, coccidiosis, respiratory infections	Fruit	Surveys	Mwale et al. (2005); Masimba et al. (2011); Maroyi (2012)
Capsicum frutescens	Solanaceae	Respiratory infections	Fruit	Survey	Chavhunduka (1976)

(continued)

Table 12.1 (continued)

Botanical name	Family	Ethnomedicinal use: poultry diseases/ symptoms	Plant part	Nature of study	References
Cassia didymobotrya	Caesalpinioideae	Newcastle	Leaves	Survey	Chavhunduka (1976)
Cissus vitacea	Vitaceae	Coccidiosis	Leaves	Survey	Masimba et al. (2011)
		Wounds	Leaves	Survey	
Cusonea arborea	Araliaceae	Coccidiosis	Bark	Survey	Chavhunduka (1976)
Erythrina abyssinica	Fabaceae	Diarrhoea, coccidiosis	Bark	Survey	Masimba et al. (2011)
Euphorbia matabelensis	Euphorbiaceae	Respiratory problems, diarrhoea, Newcastle disease	Bark	Survey	Masimba et al. (2011)
Ficus burkei	Moraceae	Coccidiosis, diarrhoea	Roots	Survey	Mwale et al. (2005); Maroyi (2012)
Ficus exasperata	Moraceae	Diarrhoea	Bark	Survey	Masimba et al. (2011)
		Lice	Bark		
Lannea stullmannii	Anacardiaceae	Coccidiosis	Bark	Surveys	Mwale et al. (2005); Gumbochuma et al. (2013)
		Egg laying problem	Bark		
Lycopersicon esculentum	Solanaceae	Eye problems	Leaves	Survey	Mwale et al. (2005); Masimba et al. (2011); Maroyi (2012)
Myrothamnus flabellifoilius	Myrothamnacea	Coccidiosis, diarrhoea	Roots	Surveys	Mwale et al. (2005); Maroyi (2012)
Nicotiana tabacum	Solanaceae	Respiratory infections	Leaves	Survey	Chavhunduka (1976)
Parinaria curatellifolia	Chrysobalanaceae	Coccidiosis, fowl typhoid, diarrhoea	Bark	Surveys	Mwale et al. (2005); Masimba et al. (2011); Maroyi (2012)
Sarcostemma viminale	Apocynaceae	Diarrhoea, coccidiosis	Stem	Surveys	Mwale et al. (2005); Masimba et al. (2011); Maroyi (2012)
Sesanum angustifolium	Pedaliaceae	New castle	Fruit	Surveys	Matekaire and Bwakura (2004); Maroyi (2012)
Solanum indicum	Solanaceae	Eye problems	Fruit	Survey	Matekaire and Bwakura (2004)
Zea mays	Poaceae	Nervous symptoms	Seeds	Survey	Chavhunduka (1976)

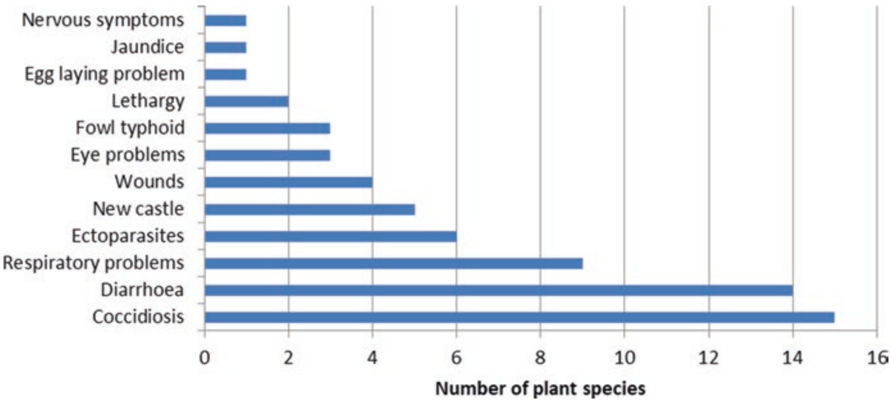

Fig. 12.1 Common ailments affecting chickens in communal areas and the number of plant species cited as remedies in Zimbabwe

12.5 Pharmacological Activity of Ethnomedicinal Plants

There have not been many detailed scientific studies in Zimbabwe on issues of determination of pharmacological properties of most ethnoveterinary plants. This can be attributed to several factors, key among them include unavailability of research funds, unavailability of equipment and issues to do with policy neglect, to ethnopharmacology development. However, some of the plants have been studied in detail in other countries and information on their activity published. There is scientific evidence that indeed these plants do have medicinal properties. Among the most studied plant genera is *Aloe,* which features in most articles on poultry health management. The bioactivity (anti-inflammatory, antioxidant, antimicrobial and immune modulatory activities) of *Aloe* extracts explains the widespread and successful use of the *Aloe* species in avian ethnomedicine (Agarry et al. 2005; Im et al. 2010; Saritha et al. 2010; Devaraj and Karpagam 2011). There is still a lot more to do for the many plant species that have been identified from surveys to screen them and truly establish their pharmacological value.

12.6 Challenges to Ethnomedicine Development in Zimbabwe

12.6.1 Poor Acceptability of Ethno Practices in Modern Agriculture

One of the major drawbacks that has slowed down the standardisation and integration of ethno-solutions in animal production in Zimbabwe is the wrong perception that traditional remedies are not effective. Unfortunately, the private sector and some veterinary professionals are the main culprits when it comes to preferring

Table 12.2 Plant-based products used in Zimbabwe for control and treatment of animal parasites and diseases in cattle and goats

Condition	Ethnoveterinary remedy	Family	Plant part	Nature of study	References
Dermatophilosis/lumpy skin disease	*Cissus quadrangularis*	Vitaceae	Stems	Survey	Ndhlovu and Masika (2012)
	Pterocarpus angolensis	Papilionideae	Roots	Survey	Ndhlovu and Masika (2012)
	Kalanchoe lanceolata	Grassulaceae	Bark	Survey	Ndhlovu and Masika (2012)
	Aloe sp.	Aloaceae	Leaves, stem	Survey	Ndhlovu and Masika (2012)
	Urginea sanguinea	Hyacinthaceae	Leaves	Survey	Ndhlovu and Masika (2012)
	Acacia sp.	Fabaceae	Bulb	Survey	Ndhlovu and Masika (2012)
	Dichrostachys cinerea	Fabacaea	Leaves	Survey	Ndhlovu and Masika (2012)
	Cassia abbreviata	Fabaceae	Bark	Survey	Ndhlovu and Masika (2012)
	Ximenia caffra	Olaceae	Fruits	Survey	Ndhlovu and Masika (2012)
	Bridellia mollis	Phyllanthaceae	Leaves	Survey	Gumbochuma et al. (2013)
Ticks and tick-borne diseases	*Lippia javanica*	Verbenaceae	Leaves	Survey & on station experiment	Madzimure et al. (2011); Nyahangare et al. (2015)
	Strychnos spinosa	Strychnaceae	Unripe fruits	In vivo & survey	Madzimure et al. (2013); Nyahangare et al. (2015)
	Solanum panduriforme	Solanaceae	Ripe fruits	In vivo	Madzimure et al. (2013)
	Tephrosia vogelii	Fabaceae	Leaves	In vivo	Gadzirayi et al. (2009)
	Maerua edulis	Capparidaceae	Leaves and tubers	Survey, in vitro, in vivo	Nyahangare et al. (2015, 2016, 2017)
	Aloe sp	Aloaceae	Leaves	Survey, in vivo	Ndhlovu and Masika (2012); Nyahangare et al. (2015, 2017)
	Sphenostylis erecta	Fabaceae	Root	In vitro efficacy	Chikwanda et al. (2013)
	Cissus quadrangularis	Vitaceae	Stems	In vitro, in vivo efficacy	Nyahangare et al. (2012, 2017)

(continued)

Table 12.2 (continued)

Condition	Ethnoveterinary remedy	Family	Plant part	Nature of study	References
	Cassia abbreviata	Fabaceae	Leaves	In vitro, in vivo efficacy	Nyahangare et al. (2015)
	Psydrax livida	Rubiaceae	Leaves	Survey	Nyahangare et al. (2015)
	Colophospermum mopane	Fabaceae	Leaves and ashes	Survey	Nyahangare et al. (2015)
	Neorautanenia brachypus	Fabaceae	Tuber	Survey	Murungweni et al. (2012); Nyahangare et al. (2015)
	Canthium huillense	Rubiaceae	Leaves	Survey	Nyahangare et al. (2015)
	Cucumis anguria	Cucurbitaceae	Leaves	Survey	Nyahangare et al. (2015)
	Combretum Imberbe	Combretaceae	Leaves	Survey	Nyahangare et al. (2015)
	Croton gratissimus	Euphorbiaceae	Leaves	Survey	Nyahangare et al. (2015)
	Monadenium lugardae	Euphorbiaceae	Stems	Survey	Nyahangare et al. (2015)
	Vigna unguiculata	Leguminosae-Papilionaceae	Leaves	Survey	Nyahangare et al. (2015)
	Datura stramonium	Solanaceae	Leaves	Survey	Nyahangare et al. (2015)
	Osyris lanceolota	Santalaceae	Leaves	Survey	Nyahangare et al. (2015)
	Ricinus communis	Euphorbiaceae	Leaves	Survey	Nyahangare et al. (2015)
	Terminalea sericea	Combretaceae	Leaves	Survey	Nyahangare et al. (2015)
	Ornithogalum sp	Asparagaceae	Roots	Survey	Nyahangare et al. (2015)
	Carissa edulis	Apocynaceae	Leaves	Survey	Nyahangare et al. (2015)
	Albizia amara	Fabaceae	Leaves	Survey	Nyahangare et al. (2015)
	Kleinia sp.	Asteraceae	Leaves	Survey	Nyahangare et al. (2015)
	Neorautanenia mitis	Fabaceae	Leaves	Survey	Maroyi (2012)
Septic wounds	*Cissus quadrangularis*	Vitaceae	Stems	Survey; review	Gumbochuma et al. (2013); Marandure (2016)
	Kigelia africana	Bignoniaceae	Fruits	Review	Marandure (2016)

	Aloe species	Aloaceae	Stems	Survey	Van de Merwe et al. (2001); Gumbochuma et al. (2013)
	Calpurnia aurea	Fabaceae	Leaves	Survey	Hutchings et al. (1996); Mukandiwa et al. (2012)
	Psydrax livida	Rubiaceae	Leaves	Survey	Chavhunduka (1976); Maroyi (2012)
	Clausena anisata	Rubiaceae	Leaves	Survey	Chavhunduka (1976)
	Spirostachys africana	Euphorbiaceae	Bark	Survey	Hutchings et al. (1996)
	Canthium huillense	Rubiaceae	Leaves	Survey	Matekaire and Bwakura (2004)
	Cissus quadrangularis	Vitacea	Leaves	Survey	Gumbochuma et al. (2013)
Internal parasites	*Vernonia amygdalina*	Compositaceae/ Astaraceae	Leaves	Survey	Matekaire and Bwakura (2004); Maroyi (2012)
	Musa paradisiaca	Musaceae	Roots	Survey	Matekaire and Bwakura (2004); Maroyi (2012)
	Aloe sp.	Aloaceae	Stems	Survey	Matekaire and Bwakura (2004)
	Sarcostemma viminale	Asclepiadaceae	Leaves	Survey	Maroyi (2012); Gumbochuma et al. (2013)
	Strychnos madagascariensis	Strychnaceae	Roots	Survey	Gumbochuma et al. (2013)
	Moringa oleifera	Moringaceae	Leaves and seeds	Survey	Gumbochuma et al. (2013)
	Solanum panduriforme	Solanaceae	Roots	Survey	Marandure (2016)
Eye infections	*Cissus quadrangularis*	Vitaceae	Stems	Survey	Maroyi (2012)
	Adenium multiflorum	Apocynaceae	Leaves	Survey	Maroyi (2012)
	Pterocarpus angolensis	Fabaceae	Bark	Survey	Maroyi (2012)
	Solanum sp.	Solanaceae	Fruit	Survey	Maroyi (2012)
Bone fractures	*Bulbophyllum* sp.	Orchidaceae	Bark	Survey	Maroyi (2012)
	Poulzozia mixta	Urticaceae	Stems	Survey	Marandure (2016)

(continued)

Table 12.2 (continued)

Condition	Ethnoveterinary remedy	Family	Plant part	Nature of study	References
Bloat	*Bridelia mollis*	Phyllanthaceae	Leaves	Survey	Gumbochuma et al. (2013)
	Pouzolzia mixta	Urticaceae	Leaves	Survey	Maroyi (2012)
	Amaranthus gneizaus	Amaranthaceae	Leaves	Survey	Marandure (2016)
Snake bite	*Musa paradisiacal*	Musaceae	Stem	Survey	Marandure (2016)
	Pouzolzia mixta	Urticaceae	Stem	Survey	Gumbochuma et al. (2013); Marandure (2016)
Retained after birth	*Xeroderris stuhlmanni*	Fabaceae	Bark	Survey	Gumbochuma et al. (2013)
Diarrhoea	*Sarcostemma viminale*	Asclepiadaceaae	Leaves	Survey	Maroyi (2012)
	Parinari curatellifolia	Chrysobalanaceae	Bark	Survey	Maroyi (2012)
	Albizia amara	Fabaceae	Leaves	Survey	Maroyi (2012)
	Ficus burkei	Moraceae	Root	Survey	Maroyi (2012)
	Myrothamnus flabellifoilius	Myrothamnaceae	Root	Survey	Maroyi (2012)
	Capsicum annuum	Solanaceae	Fruit	Survey	Maroyi (2012)
	Annona senegalensis	Ammonaceae	Leaves	Survey	Gumbochuma et al. (2013)
Foot and mouth	*Strychnos madagascariensis*	Strychnaceae	Leaves	Survey	Gumbochuma et al. (2013)
Goitre	*Aneilema hockii*	Commelinaceae	Leaves	Survey	Maroyi (2012)
Fleas	*Pseudolachnostylis maprouneifolia*	Phyllanthaceae	Leaves	Survey	Maroyi (2012)

conventional medicine to complementary medicine. The ripple effect is that there has not been meaningful local funding channeled towards research and development of herbal remedies in the country. Private companies should take a leading role and complement research efforts on development of ethnobotanicals. The situation has been exacerbated by the fact that our local universities and colleges that teach veterinary and agricultural sciences have not included ethnoveterinary modules in their curricula. As a result, knowledge of ethnomedicine is still restricted to rural folks who still use traditional methods to treat their animals.

12.6.2 Lack of Standardised Protocols

The absence of standardised protocols is also a notable challenge to the full development of ethnoveterinary products. There are diverse methods from different areas on how the traditional products are harvested, prepared and applied. Because of these variances, it has not been easy to find the most appropriate method to use because different methods produce different efficacy results making it hard to even inform policy on how plant extracts should be used. For example, across the board farmers use water to extract active compounds and they say that it is very effective. Replication of that activity under controlled laboratory and filed conditions has however proven otherwise. Research has also shown that water is not the best of extractant because of polarity issues.

12.6.3 Intellectual Property Rights Issues

Issues of property rights are crucial in trying to bring stakeholders together in the development of ethno products. One of the suspicions that farmers often cite during ethnobotanical surveys is that researchers "steal" information and make money while farmers do not have anything to show for their knowledge. It is a complex issue but Zimbabwe is fortunate that the southern Africa regional patenting office, ARIPO, is based in Harare and should be getting information readily. It is not clear what role property rights play, but what is apparent is that yet there are not many patented traditional veterinary products in Zimbabwe. At least this is consistent with what was observed by some authors where they found many publications but very few developed commercial products (Isman and Grieneisen 2014).

12.6.4 Seasonality Availability of Plant Secondary Metabolites

Many of the traditional products used to treat livestock ailments are of plant origin and as such many of them are seasonally available. This presents a challenge to promoters of ethno-pharmacological technologies because ideally the medicines are supposed to be available all the time. More so, even if the plants are available it is known that plant secondary metabolites vary as the seasons progress (Sarasan et al. 2011). It is therefore apparent then that in a year there are times of availability and scarcity of the products in quantity and content. Mechanisms must be put in place to circumvent this challenge and make plants available all year round perhaps by employing propagation and biotechnological techniques.

12.6.5 Absence of Policy on Use of Ethnoveterinary Plants

The Zimbabwean government does not have a clear policy on the promotion and development of health products from ethnoveterinary plants. There is one model that is used for all drugs and medicine and controlled by Medicines Control and Access of Zimbabwe (MCAZ). In this current set up, it is close to impossible to register an ethnoveterinary drug because the system is pro synthetic and pro commercialisation and sometimes these types of ethnoveterinary products may not meet these tight controls. For this industry to develop, the government must create a conducive environment that encourages the registering of ethno products because farmers are using the products anyway.

12.6.6 Correct Plant Species Identification

The correct identification of plants is an integral part in the whole process of ethnobotanical product development. It is not enough to have oral descriptions and names of plants effective for certain ailments. A sample of the plant should be taken and prepared for positive identification by a qualified botanist, accompanied by deposition of voucher specimens in a recognised herbarium. It is the only way that researchers can be totally sure of what plant species or sub species they are using. More often than not, what farmers and local people claim may not be true when formal identification is done. What we have realised is that local people may call different plants by the same vernacular name because most of these names are usually descriptive of what the plant can do. An example is "Muvengahonye" which can be translated to "*Maggot hater*" is a name given to several plants like *Psydrax livida* and *Clausena anisata* used to treat wound myiasis (Nyahangare et al. 2015). In the absence of physical identification, it will be difficult to have the correct plant species name.

12.6.7 Phytochemical Analysis

Very few studies have been carried out locally to determine the chemical constituents of effective plants. This is largely owing to inadequate infrastructure and expertise to characterise and isolate the active ingredients. Equipment for this kind of work is very costly and most of our universities and colleges do not have adequate facilities. There have been meaningful collaborations with other well-resourced institutions in the region and abroad, giving conclusive evidence on some of the active compounds. This however increases risks of biopiracy in the event of collaborations with unscrupulous partners.

12.7 Future Perspectives for Ethnomedicine in Zimbabwe

Zimbabwe is a country endowed with a rich culture and plant diversity, which are two essential ingredients for ethnoveterinary products development. While available literature shows that there has not been much done to explore and really grow this industry, the potential for the development of very good products is a reality. More ethnobotanical surveys need to be done covering different agro-ecological zones of the country. At the same time, these products must undergo screening for efficacy in vitro and subsequently in vivo. Other aspects that have to be addressed include testing for toxicity, environmental persistence and residual effects of the products. It can be done because other countries have done it before and are still doing it. Neighbouring South Africa has managed to produce commercially available products to the market. If this is to be achieved, there must be a lot of buy-in and working together by the government, the private sector and developmental agencies. The country will benefit from establishment of centres of excellence specifically for botanical products development.

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Chapter 13
Ethnoveterinary Practices in the Maghreb

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Keywords Medicinal plants · Ecological knowledge · North Africa · Morocco · Healing · Tradition

13.1 Introduction to the Maghreb

The Maghreb is the north-westernmost region of North Africa, comprising mainly Morocco, Algeria, and Tunisia, but also Libya and Mauritania (Fig. 13.1a). However, the Maghreb is a highly diverse and complex region both geographically and historically, which makes it difficult to delimit. The origin of the term Maghreb goes back to the dawn of Islamization (late seventh century to the beginning of eighth century), when the word was used to refer to the lands of newly Islamized North Africa lying west of the Nile. The first Arab geographers and conquerors (late seventh century) used the terms *al-maghrib* or *bilad al-Maghrib* ("the sunset"), and *jazirat al-Maghrib* (the island of the sunset) to refer to the vast area occupied by the Amazigh (Berber) Bilad al-Barbar tribes (Lazhar 2015). In the Middle Ages, *al-Maghrib* continued to designate Islamized North African lands. During the French colonisation of Algeria, Tunisia and Morocco, the Maghreb referred to the well-watered regions of French North Africa, as opposed to the arid regions of the Sahara. After independence, the term was used to designate the three states

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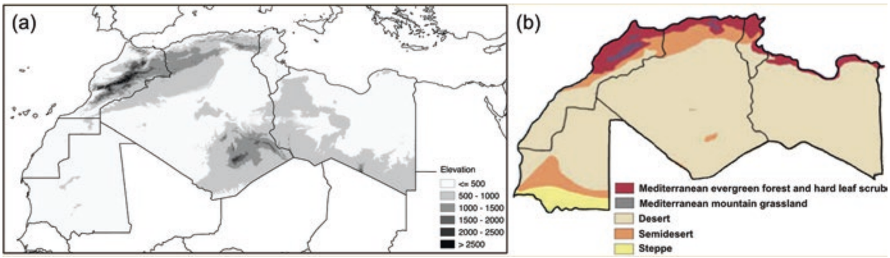

Fig. 13.1 (**a**) North African political and elevation map of Morocco, Algeria and Tunisia (Little Maghreb) as well as Libya and Mauritania (the Greater Maghreb); (**b**) vegetation types in the Maghreb. (Adapted from Wikimedia Commons)

stemming from the French colonisation: Morocco, Algeria and Tunisia. On 17 February 1989, a declaration establishing the Arab Maghreb Union (AMU) was signed in Marrakech for the purpose of economic and political complementarity by the five heads of state of Mauritania, Libya, Tunisia, Algeria and Morocco (Lazhar 2015). To avoid confusion, Morocco, Algeria and Tunisia are called Little Maghreb or simply Maghreb. The Greater Maghreb area includes Mauritania and Libya, acknowledging the geographical proximity and interconnected historical past of the five countries. If not stated otherwise, in this study we use the term Maghreb to refer to the Little Maghreb, excluding Mauritania and Libya.

13.1.1 Physical Geography

The geography of the Maghreb is characterised by the Mediterranean and Atlantic coastlines, the plains of the Atlantic facade, the mountain ranges of Atlas, Rif and Tell, the high plains and arid regions the Sahara Desert and its oases, as well as humanised landscapes including urban and peri-urban spaces (Bellakhdar 2003).

Four geographical areas can be distinguished in Morocco: The Rif, the Moroccan plateau, the Atlas (the High Atlas, the Middle Atlas and the Anti-Atlas) and the Sahara. The Rif contains mountain ranges that are located in the north of the country bordering the Mediterranean. The plateau extends from the southern borders of the Rif chain to the Middle Atlas ranges, and from the Atlantic to the West to Moulouya in the East. It has vast plains and plateaus of low or moderate altitude. The Atlas comprises three massifs: the Middle Atlas chains are oriented from South to West and from North to East, the High Atlas is an East-West barrier making North-South access difficult including the highest peak in North Africa (Djebl Toubqal, 4000 m), and the Anti-Atlas is an ancient massif extended by the Jebel Saghro and connected to the High Atlas by an ancient volcano (Jebel Siroua). Finally, Saharan Morocco is made up of vast stony *hamadas* stretching from the Atlas to Mauritania, reaching the Atlantic (Lazhar 2015).

Algeria is located between the Mediterranean Sea and the Saharan desert, and its varied natural environments are arranged from North to South. Three spaces can be distinguished: coastline, mountains and plains. The Algerian Mediterranean coast has Tellian ranges and steep reliefs that open onto marshy plains. The western Tell is marked by mild reliefs. In the north and central parts of the country, the relief is less dense with open plains leading to the sea. The eastern Tell from Algiers to Annaba is the most mountainous area. The plains are the country's most fertile lands: in the interior of the country, high plains extend up to the pre-Saharan mountains. These high plains are bordered by the Saharan Atlas that extends from West to East. Towards the South, high plateaus extend to the Saharan Atlas. The Algerian Sahara includes sand seas and mountains such as the Mzab (Lazhar 2015).

Tunisia is the easternmost of the three Maghrebi states. It is located at the junction of the eastern and western basins of the Mediterranean, with coastlines to the North and East. The country is bordered by Algeria to the West and Algeria and Libya to the South. The northern and western part of Tunisia is mountainous, which surrounds the plains in the centre of the country. The southern part of Tunisia lies within the Sahara Desert and is composed of large rocky plateaus and oriental dunes (Lazhar 2015).

13.1.2 Climate and Vegetation

The Maghreb has a varied range of climatic conditions, from humid Mediterranean to semi-arid and arid climates. Its western coast has an Atlantic climate contrasting with the humid Mediterranean climate present along the Mediterranean coastline. Towards the interior and along the mountain ranges, the Mediterranean climate is semi-arid and modified by altitude. South of the mountain ranges, which are an effective barrier between the northern and southern areas, the climate is subtropically dry and transitions from semi-arid to desert climate in the Sahara. The Saharan region is characterised by high temperatures and an absence, except in rare cases, of precipitation (Lazhar 2015). From forests to shrublands, steppes and desert dunes, local plants are adapted to the generalised dry and warm conditions (except in the higher peaks and northern coastlines that can be cooler and wetter) and a combination of Mediterranean (to a lesser extent temperate) and Saharan (but also subtropical or Sahelian) floristic elements grow in the Maghreb (Fig. 13.1b).

Vegetation in the Maghreb is rich and diverse, constituting a key resource for the local biota (Bellakhdar 2003). It is characterised by dry forests of evergreen oak (*Quercus rotundifolia* Lam.), cork oak (*Quercus suber* L.), cedar (*Cedrus atlantica* (Endl.) Manetti ex Carrière), pines (*Pinus* spp.), Mediterranean shrublands ("maquis" and "garrigues") and by steppes and grasslands (Fig. 13.1b). Vegetation is scarce in the Sahara, but present in oases and palm groves (*Phoenix dactylifera* L.). In the humid areas of the Moroccan Rif and Middle Atlas Morocco, cedar, fir (*Abies* spp.) and holm oak forests are found and grasslands are abundant in higher altitudes. The Moroccan sub-humid Atlantic area (500–800 m) is under cultivation of cereals. The arid area of the Maghreb is covered with desert pavement (regs or *hammada*) and sand sea (ergs) (Lazhar 2015). Shrublands, originated and maintained by the degradation of forests, are by far the most diverse and species-rich ecosystems in the Maghreb, known as "maquis" when developed in siliceous soils, and "garrigues" in calcareous ones. Many aromatic plants used medicinally grow in these environments. On siliceous substrates along the Mediterranean coast, *Quercus suber* forests are common, transitioning to *Q. rotundifolia* forests in further inland domains. Various pine species also produce arboreal formations (*Pinus halepensis* Mill., *P. pinaster* subsp. *escarena* (Risso) K. Richt, *P. nigra* subsp. *salzmanii* (Dunal) Franco). In higher altitudes and wetter climates, the beautiful and characteristic *Cedrus atlantica* forests can be found as well as juniper forests (*Juniperus* spp.). Higher up, fir forests are found. In lower lands with maritime influences, *Tetraclinis articulata* (Vahl) Mast. forests are characteristic of the Maghreb while in subtropical climates, endemic argan tree (*Argania spinosa* (L.) Skeels) forests grow. Steppes are found in arid environments and usually have a low biodiversity in contrast with higher altitude grasslands. Saharan ecosystems, although being the least diverse of all, introduce interesting floristic elements to the Maghreb with various species of acacias and other subtropical and Sahelian plants (Bellakhdar 2003).

13.1.3 History and Culture in the Maghreb

Placed at a cultural crossroads, the Maghreb is a land of contact between populations of different origins. The Amazigh (Berbers) have inhabited the Maghreb since at least 10,000 BC (Ilahiane 2006), interacting with populations of the northern Sahara since early times, and later with Phoenicians, Carthaginians, Romans, Hebrews, Byzantines, and Vandals. Some of these peoples had little cultural impact on Maghrebi culture, while others settled down and their influence is still noticeable today. Since the mid-seventh century AD, a continuous movement of Arab populations arrived in the Maghreb at the dawn of Islam, bringing their religion and beliefs, traditions and know-how. However, it was only in the eleventh to thirteenth centuries that the greatest migrations from Arabia and the Middle East occurred due to the rapid growth of Bedouin tribes, who were fleeing from Arabia and Upper Egypt, spreading and settling throughout the Maghreb, from the coastal areas to the Sahara. These migrants progressively settled in desert zones, the steppes and the plains, to the detriment of the Amazigh who were pushed to occupy the inaccessible mountain regions (Bellakhdar 2003). Andalusian populations of Muslims and Jews fleeing Spain after the Iberian Peninsula was conquered by Christians, as well as sub-Saharans from Sudan brought as slaves along the trans-Saharan trade routes also settled in the Maghreb. Finally, in the fifteenth century, the arrival of the Turks from the Ottoman Empire in Algeria and Tunisia, brought Asian and Balkan blood that melted into the local human melting pot. European settlers and colonisers of the

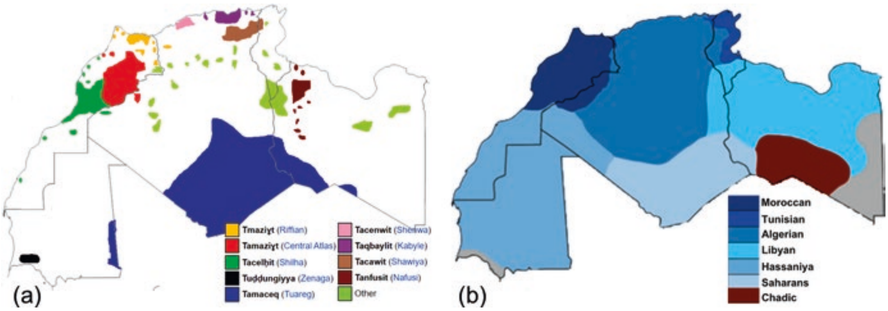

Fig. 13.2 (**a**) Amazigh languages and (**b**) Arabic dialects spoken in the Greater Maghreb. (Adapted from Wikimedia Commons)

twentieth century did not significantly mix with local populations, but their presence had an important impact on culture and lifestyles.

Whilst the Amazigh and the Arab-Islamic cultures were the most decisive elements forging the identity of the Maghreb, from this fusion of human communities an original culture was born, enriched by the multiple contributions from all civilisations that were (and still are), at one time or another in history, in contact with the Maghreb. Such cultural richness is reflected in the linguistic diversity of the region, which includes two major Afro-asiatic languages: Amazigh and Arabic (Fig. 13.2). In the Greater Maghreb, 11 of the 12 Amazigh dialects are spoken including: Tmaziɣt (Riffian), Tamaziɣt (Central Atlas), Tacelḥit (Shilha), Tuḍḍungiyya (Zenaga), Tamaceq (Touareg), Tacenwit (Shenwa), Taqbaylit (Kabyle), Tacawit (Shawiya), Tanfusit (Nafusi), Wargli and Mozabite (Fig. 13.2a). In addition, seven variants of Arabic are spoken in the region, including: Moroccan, Algerian, Tunisian, Libyan, Hassaniya, Saharans and Chadic (Fig. 13.2b).

13.1.4 Pastoral Livelihoods and Animal Husbandry

The most relevant livelihood strategies in the Maghreb include rain-fed and dryland mixed farming systems (arable and pastoral) in northern coastal regions, highland winter fall-fed mixed farming (chiefly in the Moroccan Atlas mountains), followed by semi-nomadic pastoral livelihoods and, in most southern arid regions, sparse nomadic pastoralism. Traditional livelihoods are undergoing profound changes. For example, a trend of sedentarisation is observed throughout the Maghreb, a process that has occurred over centuries. In Morocco, the number of nomads recorded in 2014 stood at 25,274 compared to 68,540 in 2004, a decrease of 63%, representing just over seven nomads per ten thousand inhabitants or 0.07% of the total population (HCP 2018). Nomadic Algerians after independence represented 10% of the population, in 1998 environs 260,000 individuals (1% of the total population)

(ONS-RGPH 1998), and in 2008 their population had diminished to little over 220,000 (ONS-RGPH 2008). Similarly, in Tunisia, nomadic livelihoods have almost disappeared. In 1860, it was estimated that nomads (approx. 600,000 people) slightly exceeded sedentary population, while currently they only represent a small percentage of the whole population (Sandron 1998).

The most important livestock species in the Maghreb are herds of sheep, goats, and camels (especially in the most arid areas), as well as cattle and poultry. According to the existing time series on husbandry stocks from 1961 to 2016 in the Maghreb (FAO 2018), sheep and goats represent by far the most dominant species. With over 25 million caprine and ovine heads in Morocco and Algeria and almost eight million in Tunisia, these are followed by bovine cattle (with a few million heads in Morocco and Algeria, and more than half a million in Tunisia). Chickens (approx. 200,000 animals in Morocco and in Algeria, and half a million in Tunisia), camels (300,000 head in Algeria and 200,000 in Morocco) and horses (200,000 head in Morocco and 50,000 in Tunisia and Algeria) are also important livestock. However, the diversity of species and proportions of domestic animals in the Maghreb have varied over time, affecting the associated ethnoveterinary knowledge. Over the last six decades, the number of Maghrebi ovine and caprine stocks have fluctuated around an annual mean average, except in Algeria, where flocks have significantly increased. For bovine cattle, Morocco and Tunisia have fluctuated slightly, while Algeria has more than doubled its numbers since 1961 (FAO 2018). The number of chickens has constantly been rising since the 1980s in all three Maghrebi countries, and increasing by 16-fold over the last six decades. In non-Saharan Morocco, stocks of horses and camels have diminished since the 1960s (FAO 2018). In Saharan regions, camels have more than tripled over the last six decades. For Algeria, stocks of camels and horses have followed opposite directions, the first increasing with time and the second diminishing, with the divergence occurring from the mid-1980s to the mid-1990s. In Tunisia, camels have had fluctuating populations over the last decades, stabilising from the 1990s onwards, while horses drastically diminished after 1980 maintaining at a low level until the present (FAO 2018).

In the Maghreb, the *beldi* and *roumi* dichotomy is used to differentiate what is local from what is foreign, and is widely used to distinguish local animal breeds (*beldi*) from animal breeds that came from elsewhere (*roumi*; Jabiot 2015). As local animal breeds are currently being replaced by more productive, but less adapted ones (Domínguez 2017), this distinction could have important implications in ethnoveterinary medicine. Foreign breeds are sought to develop new products (for example, goat cheese; Jabiot 2015) or increase meat production (Domínguez 2017). Although less productive, *beldi* breeds are considered better for human health and carry cultural meaning, as they are associated with festivities and rituals (Jabiot 2015). There is also the perception that *beldi* breeds will be healed using *beldi* or local remedies, whereas *roumi* breeds may necessitate *roumi* or biomedical therapies (Teixidor-Toneu, *pers. obs.*).

13.2 Ethnoveterinary Knowledge and Practice in the Maghreb

13.2.1 The Documentation of Ethnoveterinary Medicine in the Maghreb

Ethnoveterinary practices have scarcely been documented in the Maghreb, but dispersed information can be found in a range of academic or semi-academic works. Studies are based on fieldwork, academic literature reviews or a combination of both. The core of our literature review consists of 24 sources including 5 books, 1 master's thesis, 6 doctoral theses and 12 journal articles, published between 1926 and 2017. Most books are older sources, whereas all articles were published from 1992 to 2016. Ethnoveterinary medicine is best known in Morocco, while only very limited information exists for Algeria and Tunisia, and none for Mauritania or Libya, to the best of our knowledge. Several studies have been conducted with the Touareg and Sahrawi nomads (e.g., Benchelah et al. 2000; Volpato and Puri 2014; Volpato et al. 2013a, b, 2015) and these populations are often mentioned in regional studies (e.g., Bellakhdar 1997). Information from transhumant pastoralists – and other forms of semi-nomadism – also exists (e.g., Davis 1996; Teixidor-Toneu 2017), but it is scarce.

Articles on the ethnoveterinary medicine of Africa (McCorkle and Mathias-Mundy 1992) and the Mediterranean (Pieroni et al. 2006) provide invaluable background on the beliefs, concepts and practices of ethnoveterinary medicine in the Maghreb (McCorkle and Mathias-Mundy 1992), as well as detailed information about medicinal plants for animal health (Pieroni et al. 2006). North African medicinal plants both for human and animal health have also been documented by Boulos (1983). In Morocco, the seminal ethnographic work by Westermarck (1926) gathers much information on beliefs regarding animal health and documents many ritual treatments. The books by Bellakhdar (2003) and Benchelah et al. (2000) present studies on Maghrebi and Touareg plant use in general. Overall, the focus of these studies was either to discuss the cultural and environmental context of plant use (Bellakhdar 2003; Westermark 1926) and ethnoveterinary practice (McCorkle and Mathias-Mundy 1992), to document the range of medicinal plant diversity used (Boulos 1983; Pieroni et al. 2006) or to both provide a deep ethnographic background and document useful flora (Benchelah et al. 2000).

Two field studies (Merazi et al. 2016; Volpato et al. 2015) and a literature-based study (Viegi and Ghedira 2014) focusing on veterinary ethnopharmacology conducted in the Maghreb were identified. Information on veterinary ethnopharmacology can also be found in a doctoral thesis from the *Institut Agronomique et Vétérinaire Hassan II* (Morocco). Such studies are often based on literature (El Ghalib 2005; El Kaidi 2009; Hamdani 2011; Idrissi 2016), but some have also carried out interviews with the local population (El Ghalib 2005; Fennane 2007). These theses focus on anthelmintic (El Ghalib 2005) and antiparasitic (Idrissi 2016) plants, and on toxic plants to animals (Fennane 2007; Hamdani 2011). Moreover, ethnoveterinary uses of plants and other products in the Maghreb are mentioned in studies that present local or regional ethnopharmacopoeias for human health, importantly, in the "traditional Moroccan pharmacopoeia" (Bellakhdar 1997). Veterinary plant uses were also identified in a doctoral thesis about medicinal plant use in the High Atlas (Teixidor-Toneu 2017), a regional study on medicinal plants (Bammi and Douira 2002), in phytochemical studies (Houmani et al. 2004; Lindborg 2008), essays on traditional ecological knowledge (Davis 1996), and even foraging and ethnomycology studies (Volpato et al. 2013a, b). We would expect ethnoveterinary plant uses to be mentioned in other studies focusing on medicinal plant use for human health, phytochemistry or traditional knowledge, but this information is scattered and not easily accessible.

13.2.2 Maghrebi Ethnoveterinary Medicine

Farmers and herders in the Maghreb have sophisticated ethnoveterinary knowledge and skills that has been maintained and transformed over generations (Davis 1996). In most African cultures including the Maghreb, concepts of health and illness apply to both animals and people, and often healers that treat humans, treat livestock too (McCorkle and Mathias-Mundy 1992). Human and animal medicine are also related regarding the therapeutic materials used, especially plants, which are often the same for animal and human health (e.g., Mathias-Mundy and McCorkle 1989; McCorkle and Mathias-Mundy 1992; Pieroni et al. 2006). As in human health, two broad aetiologies of disease are simultaneously recognised in the Maghreb, natural and supernatural causes. The former explains illness as a result of a loss of balance in the physical body, often due to an imbalance of the body humours, whereas the latter refers to the actions of sorcerers, gods, genies, evil spirits or to magical procedures (Foster 1976; McCorkle and Mathias-Mundy 1992). These beliefs are widespread in the Maghreb and determine the healing practices that will be used to treat illness (e.g., Greenwood 1981; Teixidor-Toneu et al. 2017). Contrasting with the four humours in ancient Greek medical theory, the humoral pathology in Muslim Africa identifies mainly hot and cold diseases that are treated by remedies of the opposite quality (e.g., Greenwood 1981; McCorkle and Mathias-Mundy 1992). Some of the supernatural beliefs that apply to both human and animal health include issues of sexual cleanliness and purity, or attacks and possession by jinni (Mateo Dieste 2010; Westermarck 1926). Some species may be more vulnerable to some types of illness than others depending on the animal's possession of *baraka*, the beneficial, blessing force from God (Westermarck 1926). Individual animals linked to marabout saints, and some animal species broadly, are perceived to have *baraka*. Sheep, horses and bees are some of the species believed to possess *baraka*, and are particularly sensitive to uncleanliness (Westermarck 1926). This results in differential treatment and species specific ethnoveterinary practices (Westermarck 1926).

13.3 Overview of Documented Ethnoveterinary Knowledge and Practices in the Maghreb

13.3.1 Types of Practices and Diseases Treated

Ethnoveterinary practices aim to keep animals healthy either by preventing illness or by curing it. They may use therapeutic materials, notably medicinal plants, as well as ritual and prayer, especially to local saints (Westermark 1926). Ethnoveterinary practices are also used traditionally to improve the quality of animal products such as milk and dairy products or meat. For example, in the High Atlas salt is fed to animals to increase the strength and flexibility of sheep and goats' guts, a desired quality during butchering (Teixidor-Toneu, *pers. obs.*). Illness is diagnosed in African ethnomedicine by identifying the most salient symptoms (McCorkle and Mathias-Mundy 1992). Symptoms are often the basis to classify diseases, but epidemiological and supernatural factors are also considered. Thus, local disease classifications rarely have a one-to-one correspondence with biomedical concepts. Ailments considered "supernatural" will most often be treated by ritual than those considered "natural" (Foster 1976; Westermark 1926).

A wide range of natural ailments is treated by ethnoveterinary medicine in the Maghreb, with digestive and respiratory conditions being amongst the most common. Diarrhoea and flatulence are most common amongst sheep and goats (Fennane 2007). Internal and external parasites are also commonly treated by traditional veterinary medicine (El Ghalib 2005; Idrissi 2016). In the region of Sidi Bel Abbes (Algeria), Merazi et al. (2016) reported that diarrhoea, respiratory issues, loss of weight, skin problems and musculoskeletal ailments are the most common among livestock. In camels and cows, ethnoveterinary practices exist to treat difficult delivery, external parasites and mastitis (Davis 1996). The most commonly reported camel diseases by Sahrawi populations are sarcoptic mange, dermatomycosis, respiratory infections and mastitis (Volpato et al. 2015).

According to supernatural beliefs, animals may become sick because they have transferred the disease from another person or animal, becoming ill because they were the recipient of someone else's ailment (Westermarck 1926). Animals are also vulnerable to attacks and possession from jinni, who are believed to interfere in both human and animal lives. Villot (1888 in Westermarck 1926) documented that local populations believed some jinni would only attack animals, and that sometimes whole flocks would become victims. Furthermore, sexual cleanness and menstruation of the person feeding or milking an animal is believed to affect animal health, causing disease, and ethnoveterinary practices are in place to avoid illness (Westermarck 1926).

13.3.1.1 Preventive Practices

Rational use of space, dietary prescriptions and beliefs about the supernatural world are among the most important preventive practices. Herders have in-depth knowledge about range ecology from fodder availability, grazing conditions, and the health of their herds, which they mobilise to take decisions about resource use (Davis 1996; Fig. 13.3). This is instrumental in making rational choices on how to use local resources that ultimately play an important role on the herd's health. While it is difficult to distinguish between the pharmacological and nutritional effects of some fodder plants with multiple phytochemicals that have an apparent medicinal effect (Pieroni et al. 2006), herding strategies have an impact on health by avoiding the build-up of dirt and disease agents in camps, grazing areas and water sources (McCorkle and Mathias-Mundy 1992). Specific movements of the herds can also avoid seasonal disease threats, or disease-bearing pests and wildlife, as well as being used consciously to provoke mild infections that confer immunity (McCorkle and Mathias-Mundy 1992).

Leading herds to graze the most nutritious pastures will also improve the herds' health, and dietary complements are also often given to livestock. Dietary supplementation contributes to well-nourished animals that are healthier and more resistant to parasites. For example, Ishelhi farmers in the High Atlas have specific knowledge about fattening diets that can be fed to livestock in particular moments (e.g., before selling) or life stages, such as during pregnancy (Teixidor-Toneu, *pers. obs.*). An important aspect of ensuring quality fodder resources is managing the reproduction and breeding of livestock, along with adapting the number of animal heads (Davis 1996), ultimately important implications for the herd's care.

Prevention of illness is also achieved through particular practices aimed at avoiding supernatural harm. For example, to prevent evil eye, special care and protection is granted to mares and fowls, cows and calves after birth, during set a number of days (Westermarck 1926). Other supernatural beliefs are less easily linked to the prevention of physical illness, but were widespread in the Maghreb. It is believed

Fig. 13.3 Sheep and goats grazing summer alpine pastures in the High Atlas, where transhumant movements make use of different altitude grazing areas during different times of the year. (Photo by Irene Teixidor-Toneu)

that a person giving barley to horses, mules or donkeys should be clean, and among the Andjra tribe menstruating women should not milk cows, sheep or goats, or the animal would become diseased. In parts of Morocco, it was believed that unclean people should not walk among sheep or they would die, neither visit beehives to prevent bees from becoming ill or producing small amounts of honey (Westermarck 1926). Ridden by an unclean rider, a horse will get sores on its back, which may happen to mules too even if they do not have *baraka* (Westermarck 1926). If an animal is possessed by jinni (supernatural beings), identified in the way it moves its head showing obvious signs of giddiness, it will be slaughtered to prevent the attack from spreading in the flock (Westermarck 1926).

Box 13.1 Fodder Plants and Their Role in Health: Camel Husbandry Among the Saharawi

In addition to the medicinal properties of plants, common forage plays a crucial role in animal health and reproduction. As shown by Volpato and Puri (2014) amongst Saharawis, the presence or absence of certain feed plants may significantly influence the healthy growth and development of camel herds (Fig. 13.4). Through a free-listing exercise with 46 Sahrawi (men and women), the cultural domain of *martaa lbal* ("camel forage") was described by Volpato and Puri (2014). Of the hundredth ethnotaxa belonging to 31 botanical families, the most culturally relevant species were *Acacia tortilis* (Forssk.) Hayne (Fabaceae), *Nucularia perrinii* Batt. (Amaranthaceae), *Astragalus vogelii* (Webb) Bornm. (Fabaceae), *Panicum turgidum* Forssk. (Poaceae), and *Stipagrostis plumosa* Munro ex T.Anderson (Poaceae), and the most mentioned families comprised Asteraceae and Fabaceae (with 12 species each) followed very closely by Amaranthaceae (11 species). A quarter of these species were mentioned as influencing the production of camel's milk or its flavour, while others were considered healthy when mixed with other plants, but that can create certain disorders if eaten alone (e.g., *Anabasis articulata* which causes diarrhoea and colic). Worth mentioning also are the relatively high number of species rich in salt (especially Amaranthaceae), the significance of protein rich plants (chiefly Fabaceae) and the predominance of the consumption of vegetative parts, but also in some cases of reproductive organs. Such diversity of plants and plant parts consumed, as well as if they are consumed fresh (or to a lesser extent dry) also allows for the availability of fodder for most of the year, if not all. Volpato and Puri's (2014) analysis of the camel forage free-lists indicated that nomadic experience and, to some extent, age were the most important factors underlying the differences among informants. Interestingly, men and women differed little in their knowledge scores. This research clearly shows the relevance of ethnobotanical knowledge to pastoralists, and the high number of species mentioned indicates the rich diversity of potential resources, the significance of a varied diet to cover different seasons and stages of plants, as well as the consequences of changing livelihoods in ethnobotanical knowledge.

Fig. 13.4 Camels from nomadic populations grazing in the Igourdan *agdal*, Moroccan High Atlas. (Photo by Ugo D'Ambrosio)

13.3.1.2 Curative Practices

Similarly to traditional human medicine, Maghrebi curative practices in animals range from the use of therapeutic materials (discussed below) to surgery and rituals including prayer and offerings. Internal ailments are often treated with beverages and foods, and fumigations are used for colds and other respiratory problems. The treatment of external parasites includes removal by hand when possible, driving livestock through rivers to wash them, lighting smudging fires and fumigating with medicinal plants the animals themselves, as well as the camps (McCorkle and Mathias-Mundy 1992).

Prayer and offerings to local saints were common in the early twentieth century. Westermarck (1926) observed that the Ulad Rafa tribe had two veterinary saints: Sisi Ali Stwan and Sidi Mhammed s-Snhaji. If a cow or ox died of disease, one of its shanks with the hoof was deposited at the one of the shrines to prevent the death of other animals and the promise of a sacrifice was made to the saint if this hope was fulfilled. Similarly, among the Igliwa tribe, when a flock of sheep or goats was afflicted by an epidemic, it was taken three times around the shrine of the patron saint in Aglu, and one of the animals was sacrificed (Westermarck 1926). In this way, the slaughter of an animal may serve to preserve the health of the rest of the flock.

Surgery is practiced in many African ethnoveterinary traditions to care for wounds, but also in obstetrics (McCorkle and Mathias-Mundy 1992). Both vegetable fibres and animal hairs are used to suture wounds (Davis 1996; Wolfgang and Sollod 1986). In Morocco, there are accounts of successful surgery to help cows during delivery. Davis (1996) documented the case of a female veterinary healer who made a mid-ventral incision with a knife extracting the live calf from the labouring cow, and closing the incision with agave fibre. The Touareg from Niger can remove infected or abscessed tissue successfully (Wolfgang and Sollod 1986). Surgery is also employed to castrate animals, and this is often performed during the dry season, when there are less chances of infection (McCorkle and Mathias-Mundy 1992).

Bone setting is also common in the Maghreb and bonesetters (called *jbar*) treat animals and humans in the same fashion (Bakker 1992). In the High Atlas, subsistence sheep and goat pastoralists are all capable of treating animal fractures. Goats are more often wounded due to their climbing habits, and sometimes sheep, and rarely donkeys and mules, are also injured. Animals are taken care of at home, where they will rest for up to 3 months in the case of the most serious injuries (Ait Baskad, *pers. comm.*). Finally, another common practice in the Maghreb both in human and animal medicine is cauterisation, used to treat a broad range of ailments (McCorkle and Mathias-Mundy 1992).

13.3.2 Therapeutic Materials for Resources

In Africa, there is empirical evidence for the efficacy of over 30% of the ethnobotanical therapeutic materials for resources (Ibrahim et al. 1984; McCorkle and Mathias-Mundy 1992; Niang 1987). Medicinal plants seem to be amongst the most common, or at least best documented, means of treatment. Medicinal plants are used in the Maghreb because they are perceived as effective, easily available and free or not expensive compared to pharmaceuticals (Fennane 2007; Merazi et al. 2016). Currently, pharmaceuticals may simultaneously be used with plants. Plants are harvested from the wild or cultivated by the farmers themselves or bought raw or processed (Fennane 2007). In Tunisia, medicinal plants used for veterinary purposes are often common and easily available (Viegi and Ghedira 2014), but in southern Morocco, some pastoral nomads travel long distances to obtain specific medicinal plants to treat their livestock (Davis 1996). Herbal remedies are used internally and externally, prepared in a myriad of ways: as infusions, decoctions, powders, drops, fumes, pastes and ointments (McCorkle and Mathias-Mundy 1992). In Morocco, plants are often prepared in multi-species mixtures as infusions, decoctions and macerations and these beverages are administered to sheep and goats using a feeding bottle (Fennane 2007). For example, against ovine diarrhoea, Fennane (2007) documented the use of water with sugar or fermented milk with corn flour, and young animals are fed a beverage with powdered henna. Many preparations are used against ovine flatulence, from the use of just lemon juice, olive oil or a mixture of the two (salted or not), to more complex preparations. For example, a mixture of henna, eucalyptus and absinthe leaves is macerated in the leftover water from olive preserves and given to the animals until healing (Fennane 2007). Other practices to treat flatulence include pulling the tongue out to aid the animal eliminate gas or to pour warm water on the animal's back followed by over feeding (Fennane 2007).

Animal parts are also used for ethnoveterinary purposes. These can be used as amulets, as well as fed or applied on the sick animal. A widespread practice in Morocco is to use dried weasel (called *fart el-hil* or *ibn-'irs*) as medicine for horses and mules; it is burned and the animals are made to inhale the smoke when they have colic (Bellakhdar 1997; Westermarck 1926). A horse that has a cold can be made to inhale the smoke of the skin and bristles of a hedgehog, burned under his nose (Westermarck 1926). Among the Ulad Buaziz, a piece of camel skin was tied around the neck of a calf that had vermin troubles (Westermarck 1926).

Whilst most diseases are treated using the local products and biodiversity, commercial products are also employed, including commercial pharmaceuticals and less conventional products. Mateo Dieste recalled that in 1998 he "was in a house in a small mountain village during a wedding and a man showed up asking for a Coke. The hosts did not have any, and the man replied that a Fanta would also do, so they gave that to him. He said that it did not matter one way or the other, since it was for the donkey who had gastric problems" (*pers. comm.*).

Through a literature review we have documented 489 different ethnoveterinary medicinal uses for 183 plant species and nine fungal, animal and mineral materials. Latin plant names cited in the various sources were cross-checked with The Plant List (TPL 2013) and The Catalogue of Life (Roscov et al. 2018) to identify accepted taxa names. An overview of these results is presented, but the studies reviewed have different research aims and methodologies, which makes the information documented in them hardly comparable (Ellen and Puri 2016).

13.3.2.1 Common Ethnoveterinary Plant Families in the Maghreb

From our review, 56 plant families have been documented in total in ethnoveterinary practices in the Maghreb. The most commonly used families for ethnoveterinary purposes in the Maghreb are Asteraceae, Cupressaceae, Lamiaceae, Fabaceae and Amaranthaceae. Overall in the Mediterranean, Pieroni et al. (2006) found that the families Asteraceae, Lamiaceae, Fabaceae and Apiaceae were most commonly used for ethnoveterinary purposes. Whilst the Asteraceae, Lamiaceae and Fabaceae are always amongst the most used families for human health, not only in the Maghreb (e.g., Bouasla and Bouasla 2017; Fakchich and Elchouri 2014; Miara et al. 2018; Teixidor-Toneu et al. 2016) but also across the Mediterranean (e.g., González-Tejero et al. 2008; Rigat et al. 2007), plants from the Cupressaceae and Amaranthaceae families are not used so often to treat human diseases.

The prominence of plants from the Cupressaceae family is due to the popular use of tar (*qtran* in Arabic; Fig. 13.5) to treat various veterinary diseases, most prominently skin and intestinal issues (Boulos 1983; Bellakhdar 1997; Lindborg 2008). The three most common tar plants in the Maghreb are Cupressaceae: *Juniperus oxycedrus* L., *J. phoenicea* L. and *Tetraclinis articulata* (Vahl) Mast. (discussed below). *Juniperus thurifera* L., as well as the Pinaceae *Cedrus atlantica* (Endl.) Manetti ex Carrière, *Pinus halepensis* Mill. and *P. sylvestris* L., are less popular but also used. When Cupressaceae and Pinaceae plants are not available,

Fig. 13.5 Tar sold in the Marrakech spice market made from *Juniperus oxycedrus.* (Photo by Ugo D'Ambrosio)

plants from other families are sourced (e.g., *Acacia gummifera* Willd., *Eucalyptus globulus* Labill. and *Olea europaea* L.; Lindborg 2008).

The salience of mineral-rich species from the Amaranthaceae family is due to the well-documented husbandry and ethnoveterinary practices in the Sahara Desert where these species are abundant. Amaranthaceae plants are mostly used by Sahrawi and Touareg people as fodder and medicinal plants for camels and dromedaries (Bellakhdar 1997, 2003; Benchelah et al. 2000; Volpato and Puri 2014; Volpato et al. 2015).

13.3.2.2 Plant Species Commonly Used in Maghrebi Ethnoveterinary Medicine

One hundred and eighty-three plant species, five fungi, one animal and one mineral were documented with veterinary uses in the Maghreb. Approximately half of this diversity had been reported only once in literature sources, but several plant uses were documented across various studies. The most important ethnoveterinary plants in the Maghreb based on the variety of uses documented and number of sources documenting them are summarised below (in alphabetical order).

Acacia tortilis (Forssk.) Hayne (Fabaceae) [Syn. *Acacia raddiana* Savi].

Vernacular names: *L-herrob, talh, talha.*

Acacia tortilis is one of the most important fodder plants for camels and dromedaries, especially during hot and dry periods when few other green food sources are available (Volpato and Puri 2014). Mixed with other animal foods, Sahrawi people give it to camels as a fattening dietary supplement (Volpato et al. 2015). The plant also has medicinal properties. In the Moroccan region of Btana, it is believed that eating this plant treats *l-gesh*, a gastrointestinal disorder in dromedaries caused by the ingestion of sand (Bellakhdar 1997) or dew (Volpato et al. 2015). Sahrawi people use it ground and applied topically to help cicatrisation and mixed with sugar and olive oil to treat diarrhoea (Volpato et al. 2015). A decoction of burned leaves or a plaster prepared with water and coal obtained from this plant's bark are used topically to treat sarcoptic mange (Volpato et al. 2015).

Allium cepa L. (Amaryllicadeae).

Vernacular names: *Besla, azalim.*

In Morocco, onion is used to treat coryza, the inflammation of the mucous membranes lining the nasal cavity, usually causing a running nose and nasal congestion, as well as eye problems among cattle and against external parasites (El Ghalib 2005; Idrissi 2016). Sahrawis use it to treat camels' post-partum prolapse, abortion, mastitis and camelpox (Volpato et al. 2015). It is also used to treat cough in camels by heating onion in oil which is then given as a dietary supplement once a day for 2 or 3 days or until the animal gets better (Volpato et al. 2015).

Allium sativum L. (Amaryllicadeae).

Vernacular names: *Thoum, toum, touma, tiskert, tissert.*

Garlic is used across North Africa and the Mediterranean for multiple purposes in veterinary medicine (Bellakhdar 1997; Boulos 1983; Pieroni et al. 2006). In Algeria, the bulbs are used mixed with olive oil against intestinal worms in cats, and in Morocco mixed with human urine as a digestive for cattle (Pieroni et al. 2006). Sahrawis use the heated or fried bulbs topically to treat post-partum prolapse and mastitis in camels (Volpato et al. 2015).

Artemisia absinthium L. (Asteraceae).

Vernacular names: *Shiba, shajrat meryem, shibat lajouz.*

Absinth is used much like the more common white wormwood (*Artemisia herba-alba*). In Morocco and Algeria, it is used to treat flatulence, intestinal worms and other gastrointestinal problems (Davis 1996; El Kaidi 2009; Pieroni et al. 2006). In the Mitidja region in Algeria, it is also believed to treat nervous diseases (Pieroni et al. 2006). It is also used against insects (El Kaidi 2009).

Artemisia herba-alba Asso (Asteraceae).

Vernacular names: *Shih,'alala, ghoreid, ifsi, tizrit, zeri, zezzeri, izeri, ifssi, abel-bel, odessir.*

Artemisia herba-alba is the most important North African antihelmintic plant (Boulos 1983; Fig. 13.6), and is also commonly used for other purposes. The essential oil of white wormwood is antiseptic, and is used against parasites and insects (Boulos 1983; El Ghalib 2005; El Kaidi 2009). The plant is fed as an anthelmintic for sheep in the Algerian regions of Mitidja and Djelf (Houmani et al. 2004; Pieroni et al. 2006), and among the Aarib tribe in the south of the Draa valley, Morocco (Davis 1996). The Aarib also use it with *Peganum harmala* L. to treat lung and nasal worms by burning the two plants together as a fumigant (Davis 1996). In the area of Essaouira (Morocco) and other parts of Morocco, it is used to treat gastrointestinal problems among goats (El Ghalib 2005; Fennane 2007). Sahrawis heat

Fig. 13.6 Fresh *Artemisia herba-alba* Asso harvested in the Moroccan High Atlas. (Photo by Irene Teixidor-Toneu)

the plant with barley peels and use it topically to treat camel mastitis (Volpato et al. 2015). A decoction of the plant is fed to treat "bees' diarrhoea" and as a smudge used as an acaricide in bee hives (Pieroni et al. 2006). The meat from goats and sheep that have fed on this plant is highly appreciated in the Maghreb (Bellakhdar 2003; Fennane 2007). A saying among the Beni Guil herder tribe of the Moroccan Dahra plateau speaks of its quality as medicine and fodder "The halfa grass helps walking, the white wormwood helps fighting and the wild orache is better than barley" (Bellakhdar 2003).

Calotropis procera (Aiton) Dryand. (Apocynaceae).

Vernacular names: *'Oshar, baranbakh, kreka, kurunk, torsha, tourza, tawarza.*

The bark and latex of this plant are used across northern North Africa to treat animal lepra and scabies (Boulos 1983; Bellakhdar 1997). The Touareg mix carbon made from the wood of *Calotropis procera* with butter to treat scabies in dromedaries (Voinot 1904 in Bellakhdar 1997). In Tunisia, the bark and latex are also used to treat scabies in camels and goats (Boulos 1983). Sahrawis use it to treat mange, but also as a nutraceutical plant (Volpato et al. 2015).

Haloxylon scoparium Pomel (Amaranthaceae) [Syn. *Hammada scoparia* (Pomel) Iljin].

Vernacular names: *Rremt, remeth, assay.*

A decoction of this plant is mixed with tobacco juice to treat scabies in Morocco and Tunisia (Bellakhdar 1997; Le Floc'h 1983 in Viegi and Ghedira 2014). This is also one of the common ethnoveterinary plants for camels used among Sahrawis (Volpato et al. 2015). In the Sahara, the plant is used to treat snake bites and scorpion stings by squeezing the juice on the bite, or boiled and used as a wash (Volpato et al. 2015). To treat camel-pox and broncho-pneumonia, a fumigation with the branches is done repeatedly in front of the camel. In this disputed territory, it is also used to treat *aulisis* (salmonellosis), *mhaz* (respiratory infections) and *buguashish* ('Kraff' disease) (Volpato et al. 2015).

Juniperus oxycedrus L. (Cupressaceae).

Vernacular names: *Taqqa, tiqqi, taga, 'ar 'ar, tamberbout.*

This plant is mostly used to produce cade oil, which is a very popular remedy in Maghrebi veterinary, as well as human medicine (Bellakhdar 1997, 2003; El Kaidi 2009; Le Floc'h 1983 in Viegi and Ghedira, 2014; Lindborg 2008; Idrissi 2016). It is used topically against scabies (Bellakhdar 1997; Idrissi 2016) and other skin diseases (Bellakhdar 1997; Le Floc'h 1983 in Viegi and Ghedira 2014; Lindborg 2008; Viegi and Ghedira 2014), as well as against insects and intestinal parasites (Idrissi 2016; Le Floc'h 1983 in Viegi and Ghedira 2014; Lindborg 2008). In the region of Ouazanne, Morocco, the fruits are macerated in alcohol together with soap powder and used internally as a digestive (Pieroni et al. 2006).

Juniperus phoenicea L. (Cupressaceae).

Vernacular names: *'Ar 'ar, ayfs, ammes.*

This plant is also used to produce tar and used in similar ways as cade oil: to treat intestinal parasites and skin diseases (Bellakhdar 1997; Lindborg 2008). In southern Morocco, treatments made of this juniper are used to treat both uterine prolapse and retained placenta (Fine 1990 in Davis 1996). In Algeria, leaves are used in decoctions to treat respiratory diseases among horses, sheep, goats and cattle (Pieroni et al. 2006), and in the region of El Haouz, Morocco, juniper is considered a good bee plant that contributes to the hives' health (Fennane 2007).

Nucularia perrinii Batt. (Amaranthaceae).

Vernacular names: *Askaf, tassak.*

This is the best fodder plant and most important salty plant for camels in Saharan regions. Sahrawis believe that it provides salt, strength and body-mass to camels and improves the quality of camel milk (Volpato and Puri 2014; Volpato et al. 2015). However, if the plant is the only pasture available to camels during the drought months, mange develops quicker (Volpato et al. 2015). As it is the case for many other salty plants, grazing this plant is believed to be an effective treatment for camels and dromedaries against *l-gesh* (gastrointestinal problems related to the ingestion of sand or dew) and *l-homsi* (a respiratory ailment; Bellakhdar 1997). In dromedaries and camels, this plant has a depurative effect (Bellakhdar 1997) and treats intestinal parasites (Volpato et al. 2015). Used as a smudge and fumigant, it treats skin ulcers from camelpox (Volpato et al. 2015). Sahrawis also use it to treat *buguashish* ('Kraff' disease) (Volpato et al. 2015).

Peganum harmala L. (Nitrariaceae).

Vernacular names: *Harmel, himhim.*

Fumigation with the seeds of *Peganum harmala* is used as a sedative for horses in the Moroccan region of El Haouz (El Kaidi 2009; Fennane 2007). They are also used to help cicatrisation of infected wounds (El Kaidi 2009). Sahrawis heat the seeds in oil and use the mixture topically to treat diseases as diverse as strokes and abscesses in camels (Volpato et al. 2015).

Ruta chalepensis L. (Rutaceae).

Vernacular names: *Fijel, aourmi, issin, zent, issel.*

This plant is used to help delivery and treat flatulence in cattle, sheep and goats (El Ghalib 2005; El Kaidi 2009; Idrissi 2016). In cattle, it is also used to treat persistent fever, and in horses to remove intestinal parasites (El Ghalib 2005; El Kaidi 2005; Idrissi 2016). It is also used against insects and worms in sheep (Idrissi 2016).

Tetraclinis articulata (Vahl) Mast. (Cupressaceae).

Vernacular names: *'Ar 'ar, azuka, imijjed.*

This Cupressaceae plant endemic from Morocco is used in similar ways to juniper species. Tar produced from old or dead wood to treat dermal diseases and skin problems, including scabies, inflamed wounds and external parasites (Bellakhdar 1997; Boulos 1983; Le Floc'h 1983 in Viegi and Ghedira 2014; Lindborg 2008). It is also used to treat internal parasites (Lindborg 2008). Sometimes tar is used in combination with cauterisation (Teixidor-Toneu, *pers. obs.*).

Thymus vulgaris L. (Lamiaceae).

Vernacular names: *Z'atra, toumss, Azouknii, tazakum, tazerkaahla.*

This plant is considered to have antiparasitic, tonic and antiseptic effects in Morocco (El Ghalib 2005; El Kaidi 2009; Idrissi 2016). A decoction of the inflorescences is used topically in cattle, goats and sheep to heal wounds, mouth and udder inflammations in the region of Ouezanne (Pieroni et al. 2006). It is also used against various gastrointestinal diseases including intestinal parasites in rabbits, to enhance digestion in cattle, and intestinal inflammations in poultry (El Ghalib 2005; El Kaidi 2009; Idrissi 2016).

Trigonella foenum-graecum L. (Fabaceae).

Vernacular names: *Helba, tifidas.*

The seeds of fenugreek are used as dietary supplements to enhance the quality of the hair of cattle, goats and sheep in Morocco and to fatten the animals before they are sold in Algeria (Pieroni et al. 2006). Sahrawis also used it as a dietary supplement for camels, but not during pregnancy, as the acidity of the seeds could cause abortion (Volpato et al. 2015). In Tunisia, the seeds are used as a purgative (Le Floc'h 1983 in Viegi and Ghedira 2014). Sahrawis also use this plant to treat diarrhoea, indigestion and colic (Volpato et al. 2015).

Box 13.2 Toxic or Medicinal? Ethnobotanical Knowledge on Seeking or Avoiding Toxic Plants

Many toxic plants are used medicinally in small quantities or topically (McCorkle and Mathias-Mundy 1992), or can be eaten as fodder (Volpato and Puri 2014). For example, Touareg populations from Niger believe ingestion of *Balanites* sp. is responsible for a disease among small ruminants with fever and jaundice as symptoms, but they use oil extracted from these plants to treat livestock skin diseases and external parasites (Wolfgang and Sollod 1986).

Toxic plants documented in the works of Fennane (2007) and Volpato and Puri (2014) belong to 24 botanical families. Whilst Asteraceae and Fabaceae are the two most prominent families with toxic, as well as medicinal plants, Euphorbiaceae species are also commonly mentioned. In the Moroccan regions of El Houz and Essaouira, *Ricinus communis* L. (Fig. 13.7), *Gladiolus italicus* Mill., and *Eryngium ilicifolium* Lam. are plants most commonly cited as toxic when animals ingest them (Fennane 2007). *Ricinus communis* is nonetheless used by Sahrawis topically to treat strokes, mastitis and udder inflammations in camels (Volpato et al. 2015).

The accidental consumption of toxic plants can produce a loss of coordination, buccal and skin afflictions, hypersalivation, constipation, a stop of the rumination, and flatulence, sometimes followed by the death of the animal in absence of treatment. Intoxications are most common among cattle, but also among sheep and goats and to a lesser extent, camels. Herders and farmers have a deep knowledge on plant toxicology: from what ailments are the result of ingesting toxic plants, toxic quantities, and for which species, age group or sex they are toxic (McCorkle and Mathias-Mundy 1992). Adaptation of grazing patterns and avoidance of certain species when feeding animals are two of the practices that manage toxic vegetation.

Fig. 13.7 One of the most toxic plants in the region, *Ricinus communis* (High Atlas, Morocco). (Photo by Ugo D'Ambrosio)

13.4 Concluding Remarks

There is a wealth of ethnoveterinary knowledge in the Maghreb that both men and women hold. Whether there is a common cultural heritage in the Maghreb regarding ethnoveterinary medicine is not known as available evidence is scattered and barely comparable. In a comparative study across the Mediterranean, Pieroni et al. (2006) found very few shared ethnoveterinary taxa, and they concluded that there was no shared Mediterranean ethnoveterinary heritage. However, a common pool of plants was observed between Morocco and Algeria (Pieroni et al. 2006), and we have also identified similarities in beliefs, practices and plant use through our literature review.

Contrary to common claims, herders in the Maghreb have the knowledge to control the various aspects of farming practice including livestock health, and women, as well as men, participate both in the caring practices and in decision-making processes regarding livestock. In fact, women are often more knowledgeable about animal health than men (Davis 1996; Merazi et al. 2016). Davis (1996) observed that among the transhumant, camel-rearing Aarib tribe in the Draa valley (Morocco), women had better ethnoveterinary knowledge and that they performed much of the work with camel livestock, also acting as animal healers (Davis 1996). Women diagnosed and treated various animal ailments, preparing and administering the botanical treatments, as well as removing parasites, helping with new-borns and sometimes performing surgery (Davis 1996).

Whilst in much of the Mediterranean, ethnoveterinary practices may be getting lost, in the Maghreb they are still being used (Pieroni et al. 2006). Nowadays, some pastoralists and farmers use pharmaceutical, government-sponsored veterinary treatments, alongside traditional animal health care. This was already observed two decades ago in southern Morocco (Davis 1996), but it is still the case among Ishelhin transhumant pastoralists in the High Atlas (D'Ambrosio and Teixidor-Toneu, *pers. obs.*). However, ethnoveterinary practices have their limitations: the diagnosis can be inaccurate, the preparation of remedies can be inconvenient and time consuming and pharmaceuticals can be more effective than local remedies (for example, in the case of antibiotics; McCorkle and Mathias-Mundy 1992), with some authors observing that this knowledge may be lost soon (Merazi et al. 2016).

13.5 Future Directions

Ethnoveterinary medicine is a fast developing area of ethnopharmacological investigation (Heinrich et al. 2009), but there continue to be important knowledge gaps in the Maghreb. Several studies have previously noted the lack of ethnoveterinary research in the Mediterranean and North Africa. Pieroni et al. (2006) called for further work in the Mediterranean basin, but this was not achieved in the last decade. This is also the case for North Africa in general and the Maghreb in particular, as has been illustrated with our literature review. To the best of our knowledge ethnoveterinary practices in Libya and Mauritania have never been documented. In the Little Maghreb, besides an in-depth study on camel health among the Sahrawis (i.e., Volpato and Puri 2014; Volpato et al. 2013a, b, 2015), information on ethnoveterinary practices is scattered, incomplete and outdated. The classic work by Westermarck (1926) focusing on beliefs surrounding ethnoveterinary practices is almost a century old. It is expected that these would have changed with the European colonisation and decolonisation process (e.g., Davis 2006), the spread of globalisation (e.g., Domínguez 2017), increased availability of veterinary alternatives and enhanced schooling (e.g., Teixidor-Toneu et al. 2017).

Besides the many gaps in ethnoveterinary research in the Maghreb, most of the studies do not accurately report on their data collection methods, both regarding traditional knowledge and information on the therapeutic materials used. Only a few articles clearly state their data collection and analysis methods, providing in-depth information on ethnoveterinary practice, but others do not have clear methodologies and only provide anecdotal data. Many sources do not present the ethnographic context; hence it is not possible to know if practices and remedies documented are particular of a group of people or specific to a region. Half of the sources we reviewed do not provide any information on the methods used for botanical plant identification and only two authors collected voucher specimens and deposited them in registered herbaria. To develop this field of knowledge on a regional scale, ethnoveterinary data collection should be carried out systematically, following international standards (e.g., Heinrich et al. 2009; Weckerle et al. 2018), and ideally cover the breadth of cultural diversity present in the Maghreb, as well as all the main livestock animals.

In the future, the research process, methodologies used and sample material identified need to be fully documented. First, ethnoveterinary studies should follow ethical guidelines (e.g., the International Society of Ethnobiology Code of Ethics, ISE 2006), be reviewed and approved by a relevant ethics committee, and obtain the necessary permits for conducting the research (as well as for collecting and transporting botanical specimens; Heinrich et al. 2009; Weckerle et al. 2018 and references therein). Every field study should accurately document botanical diversity, collecting herbarium specimens and depositing them in herbaria, evaluate how knowledge is distributed among the studied society (including differences between common and specialist knowledge), and provide an understanding on the socioeconomic and cultural context (Heinrich et al. 2009; Weckerle et al. 2018 and references therein). Ethnoveterinary medicine is part of a complex, culture-specific system of thought which forms local knowledge and gives local meaning. Thus, it is necessary to consider and explain emic concepts of plant properties, their modes of use and the ailment categories for which they are used. It is important that future research presents a comprehensive view of ethnoveterinary medicine without a priori drawing emic distinctions or only focusing on the remedies used without providing the necessary ethnomedicinal context. Local disease categories may be remarkably different to biomedical ones (McCorkle and Mathias-Mundy 1992) and describing the symptoms of diseases is most helpful to later identify ailments described in the biomedical sciences.

As it is occurring in many other parts of the world, ethnoveterinary medicine appears to be changing or even disappearing, and yet is an overlooked aspect of local ecological knowledge in the Maghreb. While various aspects and contributions of local ecological knowledge are mobilised to improve the livelihoods of the diminishing pastoral populations in the region, to the best of our knowledge ethnoveterinary knowledge is not being documented. This lack of documentation also hinders our understanding of change at regional spatial scales (Zent and Zent 2004; Saynes-Vásquez et al. 2016), as well as within local populations (i.e., intracultural variation of knowledge; Hanazaki et al. 2013), which have proven to be very informative for sustainable development.

In addition to its theoretical relevance, further research in ethnoveterinary knowledge could also have multiple applications from local to regional levels, including a minimisation of concentrated feed and the use of synthetic medicines, with the revitalisation of other sustainable practices linked to livestock and animal rearing. In addition, most relevant plants could be studied in greater pharmaceutical detail for the prospection of healthier therapeutics based on the profuse indigenous traditions and lore documented herein. Thus, to revert the loss of such ethnoveterinary practices and to improve the corpus of knowledge surrounding these practices we suggest that a systematised regional research program would be needed, including the variety of environments and cultural backgrounds found in the Maghreb. Such programs could be led by academic institutions (botany and veterinary university schools in collaboration with anthropology and linguistics departments), along with other relevant organisations to have a more holistic view of ethnoveterinary knowledge, practices and beliefs in this understudied region.

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Chapter 14
Natural Remedies for Animal Health in Latin America

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Keywords Ethnobotany · Ethnozoology · Ethnoveterinary medicine · Zootherapy

14.1 Introduction

Throughout their existence, human beings have extracted resources from nature that were indispensable to their survival and evolution. Since the beginning of civilization, these resources have included those that were extracted for the purposes of the treatment and cure of diseases and symptoms (Alves and Rosa 2007). The interactions between human populations and their environment over time have contributed to the accumulation of unique knowledge of the healing properties of resources obtained from biodiversity, both fauna and flora (Quave et al. 2010).

During the course of their evolution, humans have learned to select natural resources according to the benefit that they offered, from those that could complement food to those that would be used for the relief of ailments and diseases for themselves as well as for their domestic animals. The knowledge, methods, and beliefs associated with nonhuman animal care have given rise to a field of study

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known as ethnoveterinary medicine (McClorke 2004). According to Barboza et al. (2007), ethnoveterinary medicine is dedicated to the study of the knowledge used in the promotion of nonhuman animal health. This knowledge has been developed by human communities over many years and passed on through generations by oral tradition (Ritter et al. 2012).

Farmers and ranchers throughout the world use products obtained from plants and animals in the maintenance and conservation of animal health (Albuquerque and Oliveira 2007; Almeida et al. 2006; Agra 2007; Alves et al. 2008). Factors, such as the increased cost of veterinary services and the difficulty of acquiring synthetic drugs, have stimulated the use of these resources (Monteiro et al. 2011a, b). According to the World Health Organization (WHO), at least 80% of people living in developing countries depend to a large extent on traditional practices for the control and treatment of various diseases that affect both them and their animals (Alves and Rosa 2005).

Latin America has a population whose culture is the result of a combination of different ethnic groups, which has contributed to it becoming one of the most culturally diverse regions in the world (Alves et al. 2010). Its territory concentrates great biological diversity with 40% of the biodiversity of the planet and more than 25% of the forests of the world, which harbor a rich and diversified fauna (PNUD; IFAD, 2002). In less developed countries, the proximity of people to nature, and their adaptation to the resources available in the environment, has favored the development of broad and complex systems of tradition knowledge related to ethnoveterinary practices.

Agricultural and rural activities are the foundations of the economy in Latin America. An estimate by the International Fund for Agricultural Development (IFAD) found that approximately 64% of the rural population of Latin America and the Caribbean live below the poverty line (IFAD 2002). Difficult access to medicines due to financial shortages is one of the main factors that motivate the use of resources extracted from nature as an alternative for the control and treatment of diseases and sicknesses of livestock and herds, especially for low-income farmers. However, in spite of their importance, studies on the uses of natural resources for ethnoveterinary purposes have been neglected when compared to the plants and animals used in popular medicine for humans.

Traditional veterinary practices can offer treatments that represent accessible and affordable alternatives for the control of diseases of nonhuman animals; however, these practices have yet to be studied, evidencing the need for investigations into the traditional use of natural therapeutic products, as well as their potential efficacy (Alves et al. 2010). Ethnoveterinary studies of traditional knowledge aim to understand the beliefs and knowledge of the treatment of nonhuman animals, and perpetuating this knowledge is fundamental in this context. This chapter provides a compilation of the richness of species of animals and plants cited in the literature as used for ethnoveterinary purposes in Latin America.

14.2 Methods

14.2.1 Data Collection

To analyze the diversity of plants and animals used in traditional medicine in Latin America, available references mentioning plants and animals used for ethnoveterinary treatment were compiled. References were obtained from searches of the databases Web of Science, Scopus, and Google Scholar using combinations of key words (in English and Portuguese), such as etnoveterinária+plantas, etnoveterinária+animais, ethnoveterinary+plants, ethnoveterinary+animals, medicina+veterinária+tradicional, and traditional+veterinary+medicine. Only plants and animals identified to the species level were included in the analysis.

14.2.2 Data Analysis

The relative importance of each recorded species was calculated based on the proposal of Bennett and Prance (2000), which highlights the importance of species in relation to their therapeutic versatility. Relative importance (RI) is calculated by the following formula with the maximum possible value being 2:

$$RI = NBS + NP$$

In this formula, NBS corresponds to the number of body systems, which is obtain by dividing the number of body systems treated by a given species (NBSS) by the total number of body systems treated by the most versatile species (NBSVS), so that NBS = NBSS/NBSVS. The term NP corresponds to the number of properties, which is obtained by dividing the number of properties determined for a given species (NPS) by the number of properties assigned to the most versatile species (NPSV) as NP = NPS/NPSV.

The therapeutic indications cited by the consulted sources were grouped into 18 categories according to the International Classification of Diseases (ICD-10) of the World Health Organization (WHO): infectious and parasitic diseases; neoplasms; blood diseases and immune disorders; endocrine, nutritional, and metabolic diseases; mental and behavioral disorders; diseases of the eye and attachments; diseases of the ear; diseases of the circulatory system; diseases of the respiratory system; diseases of the digestive system; diseases of the skin; osteomuscular diseases; diseases of the genitourinary system; pregnancy, child birth, and puerperium; lesions and poisonings; external causes of mortality; unclassified symptoms and signs; and indeterminate diseases and conditions (Table 14.3).

14.3 Ethnoveterinary Practices in Latin America

Previous studies focusing on traditional veterinary practices have contributed important data and ethnoveterinary knowledge. Studies of this nature in Latin America have taken place in Argentina, Brazil, Ecuador, Trinidad and Tobago, Peru, and Mexico and have provided surveys of species of fauna and flora used to treat nonhuman animal diseases and thus are invaluable sources of the traditional knowledge and culture of the studied populations. The results of the present review are presented separately for the plants and animals used as sources of medicine for the nonhuman animals raised by humans.

14.3.1 Plants Used in Ethnoveterinary Practices

The present review found that at least 364 species of plants belonging to 99 families have been used in popular veterinary medicine in Latin America (Table 14.1), evidencing a very rich ethnobotanical knowledge of local populations with regard to plants with curative properties directed toward the treatment of diseases of nonhuman animals. The present review adds a significant number of medicinal plant species to that of a previous review on the use of plants in ethnoveterinary treatments in Latin America (Alves et al. 2010), which recorded the use of 203 species belonging to 66 families. It should be noted that the high number of species recorded in the present study still underestimates the actual number of species that are used in ethnoveterinary medicine in Latin America. This is because few countries have studies of this nature, and, especially, the region possesses rich cultural and biological diversity. These biological resources have been used by local people for medicinal purposes for centuries – a practice that has persisted over time.

The families of medicinal plants that were most frequently reported as being used in ethnoveterinary treatments were the Fabaceae (9.91%) and Asteraceae (9.91%), followed by the Euphorbiaceae (4.68%) and Lamiaceae (4.68%). The other recorded species are distributed among 95 different families. The recorded species are often used in countries of other continents, such as Africa, Europe, and Asia. In a study conducted in the African and European Mediterranean, Pieroni et al. (2006) documented that the Asteraceae, Fabaceae, and Euphorbiaceae were among the most represented plants in local ethnoveterinary medicine. Viegi et al. (2003) found medicinal plants of the families Fabaceae and Euphorbiaceae to be the most used in local ethnoveterinary practices in Italy. Similarly, Offiah et al. (2011) highlighted the family Fabaceae as the most used to cure nonhuman animals in Nigeria. Thus, it can be inferred that the botanical species associated with ethnoveterinary practices in Latin American are often used to treat animals in other regions of the world or at least belong to the same botanical family as those used in other regions.

Table 14.1 Species of plants used in ethnoveterinary medicine in South America

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Acanthaceae					
Barleria lupulina Lindl.	15	Leaves	0.21	Trinidad and Tobago	1
***Justicia secunda* Sieber ex Steud.**	11	Leaves	0.21	Trinidad and Tobago	1
Ruellia tuberosa L.	1, 14	Root	0.42	Trinidad and Tobago	2
Adoxaceae					
Sambucus australis Cham. & Schltdl.	15	-	0.28	Argentina	3
Sambucus nigra L.	9	Leaves	0.21	Brazil	4
Agavaceae					
Agave americana L.	10, 11	Leaves	0.42	Brazil, Peru	5, 6
Alismataceae					
Echinodorus grandiflorus Micheli	13	Leaves	0.21	Brazil	7
Amaranthaceae					
Achyranthes indica (L.) Mill.	14	Leaves, root	0.21	Trinidad and Tobago	2
Amaranthus quitensis Kunth	3	Aerial parts	0.21	Argentina	8
Amaranthus viridis L.	3	Aerial parts	0.21	Argentina	8
***Chenopodium ambrosioides* Hance**	1, 8, 9, 10, 12, 13, 17, 18	Leaves, aerial parts, bark	2	Argentina, Brazil, Trinidad and Tobago	3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
Chenopodium album L.	15	Aerial parts	0.28	Argentina	3
Chenopodium murale L.	15	Aerial parts	0.28	Argentina	3
Anacardiaceae					
Anacardium giganteum J.Hancock ex Engl.	10, 11	Bark	0.42	Brazil	4
Anacardium occidentale L.	1, 10, 17, 18	Fruit, bark	0.99	Brazil, Trinidad and Tobago	2, 4,5, 9, 10, 15, 16, 18, 19
Astronium urundeuva Engl.	1, 18	Leaves	0.42	Brazil	9
Mangifera indica L.	17, 18	Bark, exudates	0.21	Brazil	4
Myracrodruon urundeuva Allemão	1, 18	Bulb, bark, leaves	0.42	Brazil	10, 15
Schinus fasciculata (Griseb.) I.M. Johnst.	14, 15, 17	Aerial parts, leaves, resin	0.70	Argentina	3, 8
Schinus terebinthifolius Raddi	17, 18	Bark	0.63	Brazil	5

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Spondias mombin L.	14, 18	Bark	0.42	Brazil, Trinidad and Tobago	2, 4
Annonaceae					
Annona mucosa Jacq.	1	Leaves, exudates	0.28	Brazil	4
Annona muricata L.	15	Leaves	0.21	Brazil	4
Annona squamosa L.	1, 11	Leaves	0.42	Brazil	15
Apiaceae					
Cicuta virosa L.	15	Aerial parts	0.21	Equador	20
Coriandrum sativum L.	10, 18	Leaves	0.42	Brazil	7
Foeniculum vulgare Mill.	6, 18	Flowers	0.49	Brazil	7
Apocynaceae					
Aspidosperma pyrifolium Mart.	1, 10	Bark, aerial parts	0.42	Brazil	9, 10, 15
Aspidosperma quebracho-blanco Schltdl.	15	Stalk	0.21	Argentina	8
Hancornia speciosa Gomes	18	Bark, leaves	0.21	Brazil	15
Himatanthus obovatus (Müll.Arg.) Woodson	4	-	0.21	Brazil	17
Tabernaemontana laeta Mart.	1	Latex	*0.21*	Brazil	5
Vallesia glabra Link	1	Leaves, stalk	0.42	Argentina	8
Aquifoliaceae					
Ilex paraguariensis A. St-Hil.	10, 18	Aerial parts, root	0.84	Argentina	3, 8
Araceae					
Caladium bicolor (Aiton) Vent.	1, 18	Leaves, root	0.42	Brazil	4, 21
Dieffenbachia seguine Baill.	1	Exudates	0.21	Brazil	4
Monstera dubia Engl. & K. Krause	18	Leaves	0.28	Trinidad and Tobago	1
Synandrospadix vermitoxicus Engl.	1, 15	Tuber	0.42	Argentina	8
Syngonium podophyllum Schott	18	Leaves	0.21	Trinidad and Tobago	1
Araliaceae					
Dendropanax arboreus (L.) Decne. & Planch.	18	-	0.21	Trinidad and Tobago	1

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Arecaceae					
Acrocomia aculeata (Jacq.) Lodd.	18	Root, seeds	0.21	Trinidad and Tobago	1, 14
Astrocaryum vulgare Mart.	6	Fruit	0.21	Brazil	4
Bactris gasipaes Kunth.	1	Leaves	0.21	Brazil	4
Cocos nucifera L.	1, 4, 6, 10, 18	Fruit water, fruit oil	0.92	Trinidad and Tobago, Brazil	4, 9, 10, 16, 19
Euterpe oleracea Mart.	10, 16	Root	0.42	Brazil	4
Aristolochiaceae					
Aristolochia argentina Griseb.	12	Aerial parts	0.21	Argentina	3
Aristolochia rugosa Lam.	15	Aerial parts	0.21	Trinidad and Tobago	1
Aristolochia trilobata L.	15	Leaves	0.21	Trinidad and Tobago	1
Asclepidaceae					
Asclepias curassavica L.	15	Leaves, flowers	0.21	Trinidad and Tobago	2
Funastrum gracile Schltr.	18	Aerial parts	0.21	Argentina	8
Asphodelaceae					
Aloe saponaria Haw.	18	Mucilage	0.21	Argentina	3
Asteraceae					
Acanthospermum hispidum DC.	9	Root	0.21	Brazil	15
Achyrocline satureioides (Lam.) DC.	11	Flowers	0.21	Brazil	22
Ageratum conyzoides L.	17	Leaves, bark	0.21	Brazil	9, 10
Ambrosia tenuifolia Spreng.	1, 18	Aerial parts	0.42	Argentina	8
Arnica montana L.	1, 16, 17	Leaves	0.70	Brazil	9, 10
Baccharis crispa Spreng.	10	Aerial parts	0.21	Argentina	3
Baccharis salicina Torr. & A.Gray	9, 13	Aerial parts	0.42	Argentina	8
Baccharis trimera DC.	1, 11, 17	Leaves	0.49	Brazil	22, 23
Bidens pilosa L.	11	Flowering aerial parts	0.21	Brazil	22
Calea serrata Less.	11	Flowering aerial parts	0.21	Brazil	22

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Chaptalia nutans (L.) Polak		Flowering aerial parts	0.21	Brazil	22
Chromolaena maximilianii (Schrad. ex DC.) R.M.King & H.Rob.	10, 17	Stalk, branch	0.42	Brazil	5
Clibadium surinamense L.	1	Leaves	0.28	Brazil	4
Cichorium intybus L.	18	Aerial parts	0.21	Argentina	3
Conyza bonariensis (L.) Cronq.	10, 11	Leaves, whole plant	0.42	Argentina, Brazil	3, 22
Eclipta alba (L.) Hassk.	15	Leaves	0.21	Trinidad and Tobago	1
Egletes viscosa (L.) Less.	10	Seeds	0.21	Brazil	15
Eupatorium laevigatum Lam.	11	Leaves	0.21	Brazil	22
Eupatorium triplinerve Vahl.	9	Leaves	0.21	Brazil	16
Gaillardia megapotamica var. *scabiosoides* (Arn. ex DC.) Baker	15	Leaves	0.28	Argentina	3
Matricaria chamomilla L.	10, 11, 18	Flowers	0.70	Brazil	7
Matricaria recutita L.	15, 18	Flowers, aerial parts	0.49	Argentina	3
Mikania lindleyana DC.	10	Leaves	0.21	Brazil	16
Neurolaena lobata R.Br.	18	Leaves	0.21	Trinidad and Tobago	19
Pectis odorata Griseb.	14	Aerial parts	0.35	Argentina	8
Pluchea microcephala Godfrey	10, 15	Aerial parts	0.42	Argentina	8
Pluchea sagittalis Less.	10, 15	Aerial parts	0.42	Argentina	8
Porophyllum ruderale (Jacq.) Cass.	17	Leaves	0.21	Brazil	7
Pterocaulon cordobense Kuntze	11	Flowering aerial parts	0.21	Brazil	22
Solidago chilensis Meyen	11	Leaves	0.21	Brazil	22
Tanacetum parthenium L.	14, 15	Aerial parts, leaves	0.49	Argentina	3
Tessaria integrifolia Ruiz & Pav.	18	Stalk	0.21	Argentina	8

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Tithonia diversifolia A. Gray	11	Leaves	0.21	Brazil	4
Trixis divaricata subsp. *discolor* (D. Don) Katinas	10, 11, 15, 17	Aerial parts, root	0.92	Argentina	3
Vernonia scorpioides (Lam.) Cass.	1, 3, 9, 10, 11	Flowering aerial parts	1.13	Trinidad and Tobago, Brazil	1, 22
Xanthium spinosum L.	6, 15	Root	0.42	Argentina	3
Bignoniaceae					
Arrabidaea chica (Bonpl.) Verl.	3	Leaves	0.21	Brazil	16
Crescentia cujete L.	11, 14, 18	Fruit	0.85	Brazil, Mexico	16, 21
Jacaranda micrantha Cham.	11	Leaves	0.21	Brazil	22
Jacaranda ulei Bureau & K. Schum.	11	-	0.21	Brazil	17
Mansoa alliacea (Lam.) A.H.Gentry	18	Leaves	0.21	Brazil	16
Sparattosperma leucanthum K. Schum.	1	Leaves	0.21	Brazil	5
Bixaceae				Brazil	
Bixa orellana L.	1, 9, 11, 16, 18	Seeds	1.35	Brazil	4, 16, 21
Bombacaceae					
Ceiba pentandra (L.) Gaertn.	-	-	-	-	21
Boraginaceae					
Cordia curassavica (Jacq.) Roem. & Schult.	1	Leaves	0.21	Trinidad and Tobago	13, 19
Heliotropium indicum L.	1, 4, 17, 18	Leaves	0.85	Brazil	15, 16
Mansoa alliacea (Lam.) A.H. Gentry.	4	Leaves	0.21	Brazil	4
Brassicaceae					
Capsella bursa-pastoris (L.) Medik.	14, 18	Whole plant	0.28	Argentina	3
Lepidium didymum L.	18	Whole plant	0.21	Argentina	3
Nasturtium officinale R. Br.	3	Leaves	0.21	Trinidad and Tobago	13
Bromeliaceae					
Ananas comosus (L.) Merr.	1	Fruit, leaves	0.21	Brazil	4

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Cactaceae					
Cereus jamacaru DC.	18	Thorn	0.21	Brazil	10
Nopalea cochenillifera (L.) Salm-Dyck	12, 15, 18	Aerial parts	0.63	Trinidad and Tobago	13, 19
Opuntia fícus-indica (L.) Mill.	18	Thorn	0.21	Brazil	10
Opuntia quimilo K. Schum.	18	Stalk	0.21	Argentina	8
Capparaceae					
Capparis flexuosa (L.) L.	4, 10	Leaves, bark	0.42	Brazil	15
Capparis speciosa Griseb.	1	Bark	0.21	Argentina	8
Capparis tweediana Eichler	10	Leaves	0.21	Argentina	8
Caricaceae					
Carica papaya L.	1, 18	Leaves, fruits, root, seeds, exudates	0.49	Brazil, Trinidad and Tobago	4, 13, 16
Cecropiaceae					
Cecropia peltata L.	13, 14, 15	Leaves, root	0.85	Argentina, Brazil, Trinidad and Tobago	1, 13, 14
Celtidaceae					
Celtis ehrenbergiana (Klotzsch) Liebm.	1	Bark	0.21	Argentina	3
Clusiaceae					
Mammea americana L.	1	Bark	0.21	Mexico, Trinidad and Tobago	21, 24
Cochlospermaceae					
Cochlospermum regium Pilg	18	-	0.21	Brazil	17
Convolvulaceae					
Ipomoea asarifolia (Desr.) Roem. & Schult.	11, 18	Leaves, stalk	0.56	Brazil	9, 10, 15, 16
Ipomoea carnea Jacq.	1, 15, 18	Leaves	0.63	Brazil, Argentina	8, 16
Operculina alata Urb.	1, 11	Tuber	0.42	Brazil	15
Operculina hamiltonii (G. Don) D.F. Austin & Staples	1	Tuber	0.21	Brazil	15, 25, 30

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Operculina macrocarpa (L.) Urb.	1, 4, 18	Tuber	0.70	Brazil	9, 10, 17
Commelinaceae					
Commelina erecta L.	6, 11	Flowering aerial parts, mucilage	0.42	Argentina, Brazil	3, 22
Costaceae					
Costus spiralis (Jack.) Roscoe	13	Leaves	0.21	Brazil	7, 16
Crassulaceae					
Bryophyllum calycinum Salisb.	10, 15, 18	Leaves	0.63	Brazil	16
Kalanchoe brasiliensis Cambess.	9, 17	Leaves	0.42	Brazil	15
Kalanchoe pinnata (Lam.) Pers.	1, 11, 16, 18	Leaves	0.85	Trinidad and Tobago	2, 4, 19
Sedum dendroideum DC	17, 18	Leaves	0.42	Brazil	7
Cucurbitaceae					
Cucumis anguria L.	1, 13	Fruit, seeds	0.49	Brazil	5, 15
Cucurbita maxima Lam.	14	Seeds	0.21	Argentina	3
Cucurbita pepo L.	1, 11	Seeds	0.49	Brazil	15, 25, 30
Luffa acutangula (L.) Roxb.	10	Unripe fruit	0.21	Brazil	15, 21
Luffa aegyptiaca Mill.	10	Unripe fruit	0.21	Brazil	15, 21
Luffa operculata (L.) Cogn.	10, 17, 18	Fruit	0.63	Brazil	5, 15
Momordica charantia L.	1, 11, 14, 16, 18	Fruit, stalk, leaves	1.21	Brazil, Trinidad and Tobago	1, 13, 15, 16, 17, 19, 25, 30
Cupressaceae					
Thuja occidentalis L.	4	-	0.21	Brazil	17
Cyperaceae					
Cyperus brevifolius (Rottb.) Hassk.	11	Flowering aerial parts	0.21	Brazil	22
Equisetaceae					
Equisetum giganteum L.	13	Aerial parts	0.21	Argentina	3
Ephedraceae					
Ephedra ochreata Miers	17	Aerial parts	0.21	Argentina	3
Ephedra triandra Tull.	17	Aerial parts	0.21	Argentina	3
Eriocaulaceae					
Paepalanthus speciosus (Bong.) Koern	10	-	0.21	Brazil	17

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Erythroxylaceae					
Erythroxylum coca Lam.	14	Leaves	0.35	Argentina	8
Euphorbiaceae					
Acalypha communis Müll.Arg.	11, 15	Leaves	0.42	Argentina	3
Cnidoscolus phyllacanthus (Müll. Arg.) Fern.Casas	1	Stalk, leaves	0.21	Brazil	15
Croton blanchetianus Baill.	10	Bark	0.21	Brazil	38
Croton cajucara Benth.	10, 18	Leaves, bark	0.42	Brazil	4
Croton gnaphalii Baill.	11	Flowering aerial parts	0.21	Brazil	22
Croton gossypiifolius Vahl	18	Leaves	0.21	Trinidad and Tobago	8
Croton sonderianus Müll.Arg.	10	Bark	0.28	Brazil	15
Croton subpannosus Griseb	9	Aerial parts	0.28	Argentina	3
Croton urucurana Baill.	1	-	0.21	Brazil	17
Euphorbia prostrata Aiton.	18	Leaves	0.21	Brazil	4
Jatropha curcas L.	1, 9, 10, 18	Leaves, exudates, seeds	1.21	Brazil, Trinidad and Tobago	1, 4, 16, 17
Jatropha gossypiifolia L.	1, 6, 18	Leaves, bark	0.85	Brazil, Trinidad and Tobago	1, 15
Jatropha hieronymi Kuntze	10, 18	Fruits	0.42	Argentina	8
Jatropha mollissima (Pohl) Baill.	15	Latex, root, leaves	0.21	Brazil	4, 26
Joannesia princeps Vell.	1	Seeds	0.21	Brazil	5
Ricinus communis L.	9, 10	Seeds	0.42	Brazil	5, 15
Sapium haematospermum Müll. Arg.	15, 18	Leaves, stalk	0.42	Argentina	8
Fabaceae					
Acacia albicorticata Burkart	18	Leaves	0.21	Argentina	8
Acacia aroma Hook. & Arn.	15	Leaves, bark	0.28	Argentina, Bolivia	3, 8, 27

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Acacia caven (Molina) Molina	15	Aerial parts	0.29	Argentina	3
Amburana cearensis A.C.Sm.	1, 4, 10	Leaves, seeds	0.70	Brazil	9, 10
Anadenanthera colubrina (Vell.) Brenan	9, 17, 18	Bark	0.63	Brazil, Bolivia	4, 15, 17, 27
Bauhinia cumanensis Kunth	15	Aerial parts	0.21	Trinidad and Tobago	1
Bauhinia guianensis Aubl.	15	Aerial parts	0.21	Trinidad and Tobago	1
Caesalpinia ferrea Mart. ex Tul.	9, 10, 16, 17, 18	Bark, green beans	1.06	Brazil	9, 10, 15, 16, 17
Cassia angustifolia Vahl	17	Leaves	0.21	Brazil	9
Cassia occidentalis L.	14	Bark	0.21	Brazil, Trinidad and Tobago	2, 9
Cassia tora L.	1	Leaves	0.21	Brazil	15
Copaifera martii Hayne	1, 9, 10, 17, 18	Bark, oil	1.07	Brazil	16
Dalbergia monetaria L.f.	3, 10, 17, 18	Bark	0.70	Brazil	4, 16
Derris spruceana (Benth.) Ducke.	1, 11	Root, leaves	0.49	Brazil	4
Erythrina micropteryx Urb.	14	Leaves	0.21	Trinidad and Tobago	14
Erythrina pallida Britton	14	Leaves	0.21	Trinidad and Tobago	14
Geoffroea decorticans (Hook. & Arn.) Burkart	14	Bark, walnuts	0.35	Argentina	8
Leucaena glauca Benth.	18	Aerial parts	0.21	Mexico	21
Mimosa albida Willd.	6	Root	0.21	Mexico	28
Mimosa pudica L.	14	Root	0.21	Trinidad and Tobago	2
Mimosa tenuiflora (Willd.) Poir.	1, 17, 18	Leaves	0.49	Brazil	9, 15
Mucuna pruriens (L.) DC.	18	Leaves	0.21	Trinidad and Tobago	13
Myroxylon peruiferum L.f.	-	-	-	Bolivia	27
Phaseolus vulgaris L.	1	Seeds	0.21	Brazil	5
Pithecellobium unguis-cati (L.) Benth.	-	-	-	Trinidad and Tobago	1

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Poincianella pyramidalis (Tul.) L.P. Queiroz	10	Bark, leaves	0.28	Brazil	15
Prosopis alba Griseb.	18	Leaves, fruit	0.28	Argentina	8
Prosopis juliflora (Sw.) DC.	8	Fruit	0.21	Brazil	15
Prosopis ruscifolia Griseb.	18	Leaves, fruit	0.28	Argentina	8
Pueraria phaseoloides (Roxb.) Benth.	4	Leaves	0.21	Trinidad and Tobago	13
Senna alexandrina Mill.	1, 11, 17	Leaves, bark	0.49	Brazil	10, 15
Senna morongii (Britton) H.S. Irwin & Barneby	15, 18	Leaves	0.42	Argentina	8
Senna occidentalis L. (Link)	14	Leaves	0.21	Brazil	10, 25
Stryphnodendron adstringens (Mart.) Coville.	1, 18	-	0.63	Brazil	17
Tamarindus indica L.	10, 17	Fruit	0.42	Brazil	15
Tipuana tipu (Benth.) Kuntze	-	-	-	Bolivia	27
Gentianaceae					
Chelonanthus alatus (Aubl.) Pulle.	1, 11, 18	Leaves	0.63	Brazil	4
Tachia guianensis Aubl.	18	-	0.21	Brazil	17
Haemodoraceae					
Xiphidium caeruleum Aubl.	18	Leaves	0.21	Trinidad and Tobago	1
Humiriaceae					
Endopleura uchi (Huber) Cuatrec.	10, 18	Bark	0.42	Brazil	4
Hydrophyllaceae					
Phacelia pinnatifida Griesb. ex Wedd.	13	Whole plant	0.21	Argentina	3
Hypericaceae					
Hypericum caprifoliatum Cham. & Schltdl.	11	Flowering aerial parts	0.21	Brazil	22
Vismia guianensis (Aubl.) Choisy	18	Bark	0.21	Brazil	4
Iridacea					
Eleutherine bulbosa (Mill.) Urb.	10, 11	Root, leaves	0.49	Brazil	4

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Eleutherine plicata (Sw.) Herb.	10	Root	0.28	Brazil	16
Lamiaceae					
Calamintha officinalis Moench	10	Ramos, leaves	0.28	Brazil	15
Hyptis suaveolens (L.) Poit.	10	Leaves, flowers	0.28	Brazil	15
Lavandula officinalis Chaix	11	Aerial parts	0.28	Argentina	3
Leonurus sibiricus L.	1, 10	Ramo	0.42	Brazil	5
Marrubium vulgare L.	1,15	Aerial parts	0.42	Argentina, Brazil	3, 17
Melissa officinalis L.	17, 18	Leaves	0.42	Brazil	7
Mentha x rotundifolia (L.) Huds.	10	Aerial parts	0.21	Argentina	3
Mentha x *villosa* Huds.	1	Leaves	0.28	Brazil	15
Mentha crispa L.	10	Leaves	0.21	Brazil	16
Minthostachys verticillata (Griseb.) Epling	1, 8	Leaves, aerial parts	0.42	Argentina	3
Ocimum basilicum L.	11	Seeds	0.21	Argentina	8
Ocimum gratissimum L.	6, 9, 16	Leaves	0.70	Brazil	4
Ocimum minimum L.	9	Leaves	0.21	Brazil	4
Origanum vulgare L.	15	Aerial parts	0.28	Argentina	3
Plectranthus amboinicus (Lour.) Spreng.	9	Leaves	0.21	Brazil	15
Plectranthus barbatus Andrews	10	Leaves	0.28	Brazil	5, 7, 16
Rosmarinus officinalis L.	10	-	0.21	Mexico	28
Lauraceae					
Cinnamomum verum J.Presl.	10, 17	Leaves	0.42	Brazil	4
Laurus nobilis L.	10	Leaves	0.42	Brazil, Argentina	7, 8
Persea americana Mill.	15	Seeds	0.21	Brazil	16
Lecythidaceae					
Lecythis pisonis Cambess.	1, 11	Leaves	0.42		4
Liliaceae					
Allium cepa L.	1, 6, 9	Whole plant, bulb	0.63	Brazil	15

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Allium sativum L.	1, 8, 9, 15, 18	Whole plant, bulb	1.63	Brazil, Argentina, Trinidad and Tobago	3, 5, 8, 9, 10, 15, 16, 19
Aloe vera (L.) Burm.f.	1, 11, 14, 16, 18	Leaves, pulp	1.85	Brazil, Argentina, Trinidad and Tobago	2, 8, 9, 10,13, 15, 16, 19, 25
Smilax cognata Kunth	11	Flowering aerial parts	0.21	Brazil	22
Loganiaceae					
Strychnos pseudoquina A. St.-Hill.	3, 10	-	0.63	Brazil	17
Loranthaceae					
Ligaria cuneifolia (Ruiz & Pav.) Tiegh.	10, 14	Aerial parts	0.42	Argentina	3
Struthanthus angustifolius (Griseb.) Hauman	14	Aerial parts	0.35	Argentina	8
Tripodanthus acutifolius (Ruiz & Pav.) Tiegh.	14	Aerial parts	0.35	Argentina	8
Tripodanthus flagellaris (Cham. & Schltdl.) Tiegh.	14	Aerial parts	0.21	Argentina	3
Lycoperdaceae					
Calvatia cyathiformis (Bosc.)	1, 15	Spores	0.49	Argentina	3
Lythraceae					
Heimia salicifolia (Kunth) Link	6, 10, 17	Root, aerial parts	0.63	Argentina	3, 8
Lafoensia pacari A. St.-Hill.	18	-	0.21	Brazil	17
Malvaceae					
Gossypium barbadense L.	1, 9, 10	Leaves	0.63	Brazil	4
Gossypium hirsutum L.	15, 17	Leaves	0.42	Brazil	7, 17
Luehea divaricata Mart. & Zucc.	11	Leaves	0.21	Brazil	22
Malva parviflora L.	1, 6, 9, 15	Leaves	0.85	Argentina	3
Malva sylvestris L.	1, 10, 15, 17	Leaves	0.70	Argentina, Brazil	3, 15
Malvastrum coromandelianum (L.) Garke	15, 17	Whole plant	0.49	Argentina	3

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Pseudobombax marginatum (A.St.-Hil.) A.Robyns	13	Entre bark	0.21	Brazil	15
Sida rhombifolia L.	15, 17	Aerial parts, whole plant	0.42	Argentina	3
Melastomataceae					
Clidemia capitellata (Bompl.) D. Don.	11, 18	Leaves	0.42	Brazil	4
Leandra australis (Cham.) Cogn.	11	Leaves	0.21	Brazil	22
Meliaceae					
Azadirachta indica A. Juss.	1, 10, 18	Leaves	0.85	Brazil, Trinidad and Tobago	2, 7, 16, 19, 31
Carapa guianensis Aubl.	1, 9, 11, 17, 18	Fruit, seeds	1.56	Brazil	4, 16
Cedrela odorata L.	1, 10	Bark, leaves	0.42	Brazil, Trinidad and Tobago	15, 19
Melia azedarach L.	1	Fruits	0.21	Argentina	3
Monimiaceae					
Peumus boldus Molina	1, 10	Leaves	0.49	Brazil	9, 10, 15
Moraceae					
Dorstenia asaroides Gardner	9	Root	0.21	Brazil	16
Ficus maxima Mill.	1	Bark	0.21	Brazil	16
Musaceae					
Musa x *sapientum* L.	18	-	0.21	Brazil	17
Musa x paradisiaca L.	1	Leaves	*0.21*	Brazil	5
Myrtaceae					23
Eucalyptus cinerea F.Muell. ex Benth.	1	Leaves	0.21	Argentina	3
Eucalyptus tereticornis Sm.	9	Leaves	0.21	Argentina	8
Myrcia uniflora Barb. Rodr.	4	Leaves	0.21	Brazil	15
Myrciaria cuspidata O.Berg.	11	Leaves	0.21	Brazil	22
Pimenta racemosa (Mill.) J.W. Moore	9, 18	Leaves	0.42	Trinidad and Tobago	13, 19
Psidium guajava L.	10, 18	Brotos, leaves, bark	0.49	Brazil, Trinidad and Tobago	2, 5, 8, 9, 10, 13, 15, 25

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Psidium guineense Sw.	10, 18	Bark	0.42	Brazil	4
Ochnaceae					
Ouratea aquatica (Kunth) Engl.	10, 11, 18	Bark	0.92	Brazil	4, 16
Olacaceae					
Ximenia americana L.	17, 18	Bark, leaves, fruit	0.63	Argentina, Brazil	8, 9, 11, 15
Orchidaceae					
Sarcoglottis acaulis (Sm.) Schltr.	18	Aerial parts	0.21	Trinidad and Tobago	1
Oxalidaceae					
Oxalis corniculata L.	18	-	0.21	Trinidad and Tobago	13
Papaveraceae					
Argemone subfusiformis Ownbey	1, 18	Leaves, latex, stalk	0.42	Peru	29
Phytolaccaceae					
Petiveria alliacea L.	1, 14, 18	-	0.63	Argentina, Trinidad and Tobago	1, 2, 8, 19
Piperaceae					
Lepianthes peltata (L.) Raf. ex R.A.Howard	18	Leaves	0.21	Trinidad and Tobago	1
Ottonia ovata (Vahl) Trel.	18	Leaves, latex, root	0.21	Trinidad and Tobago	1
Piper callosum Ruiz & Pav.	10, 17	Leaves	0.42	Brazil	4, 16
Piper scabrum Sw.	18	Leaves	0.21	Trinidad and Tobago	1
Piper umbellatum L.	18	Leaves	0.21	Brazil	7
Phyllanthaceae					
Phyllanthus niruri L.	13, 18	Folha, stalk e root	0.42	Brazil, Trinidad and Tobago	1, 15, 16
Phyllanthus tenellus Roxb.	13	Leaves	0.21	Brazil	7
Phyllanthus urinaria L.	18	Leaves	0.21	Trinidad and Tobago	1
Phytolaccaceae					
Gallesia integrifolia (Spreng.) Harms	1, 17	Bark, branch	0.35	Brazil	5
Petiveria alliacea L.	18	Root, leaves	0.28	Brazil	4, 16

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Plantaginaceae					
Plantago major L.	6, 17	Leaves	0.42	Argentina, Trinidad and Tobago	3, 14
Scoparia dulcis L.	9	Whole plant	0.21	Brazil	15
Poaceae					
Bambusa vulgaris Schrad.	14	Leaves	0.28	Trinidad and Tobago	3, 29
Cymbopogon citratus (DC.) Stapf	1, 10, 17, 18	Leaves, root	1.35	Brazil	4, 7, 15, 16
Cynodon dactylon (L.) Pers.	10	Aerial parts	0.21	Argentina	8
Oryza sativa L.	14	-	0.21	Trinidad and Tobago	2
Panicum maximum Jacq.	18	Leaves	0.21	Trinidad and Tobago	13
Paspalum conjugatum P.J. Bergius	10, 17, 18	Leaves	0.63	Brazil	4, 21
Zea mays L.	1, 9, 13, 14, 18	Corn hair, flowers, cob, leaves, inflorescence	1.13	Argentina, Brazil	3, 5, 8, 15
Polygalaceae					
Polygala spectabilis DC.	1, 10, 17	Leaves	0.63	Brazil	4
Polygonaceae					
Polygonum hydropiperoides Michx.	11, 18	Leaves	0.42	Brazil	5
Polygonum punctatum Elliott	15	Leaves	0.21	Argentina	8
Ruprechtia triflora Griseb.	10	Leaves	0.21	Argentina	8
Portulacaceae					
Portulaca pilosa L.	1, 10, 17, 18	Leaves, whole plant	0.77	Brazil	4, 16
Portulaca oleracea L.	18	Aerial parts	0.21	Argentina	8
Punicaceae					
Punica granatum L.	10, 17	Fruit peel	0.56	Argentina, Brazil	3, 15
Ranunculaceae					
Clematis dioica L.	1	Leaves	0.21	Mexico	28
Clematis montevidensis Spreng.	1, 9	Fruit	0.42	Argentina	3, 8

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Rhamnaceae					
Colletia spinosissima J.F.Gmel.	15	Aerial parts	0.28	Argentina	3
Ziziphus joazeiro Mart.	1, 11, 17, 18	Bark shavings	0.70	Brazil	15
Rubiaceae					
Chiococca brachiata Ruiz & Pav.	1, 4, 10, 11, 17	-	1.27	Brazil	17
Coffea arabica L.	10, 18	Ground, fruit	0.42	Brazil, Trinidad and Tobago	5, 14
Coffea robusta L.	18	Ground	0.21	Trinidad and Tobago	14
Coutarea hexandra (Jacq.) K.Schum.	9, 18	Bark shavings, bark	0.63	Brazil	15
Pogonopus tubulosus (A.Rich. ex DC.) K. Schum.	15	-	0.21	Bolivia	27
Psychotria ipecacuanha (Brot.) Stokes	1, 9, 17	Bark	0.49	Brazil	9, 15
Staelia scabra (C. Presl.) Standl.	1	Aerial parts	0.21	Mexico	28
Rutaceae					
Citrus aurantifolia (Christm.) Swingle	9	Fruits	0.21	Trinidad and Tobago	19
Citrus x *aurantium* L.	1, 4, 9, 18	Leaves, fruits, bark	1.35	Brazil, Trinidad and Tobago	4, 14, 19
Citrus limetta Risso	1, 9, 11, 18	Fruit, leaves	1.28	Brazil, Trinidad and Tobago	19
Citrus limon (L.) Burm.	6	Fruit	0.21	Argentina	3, 4, 5, 8, 9, 10, 16
Citrus medica L.	9, 18	Fruit	0.42	Trinidad and Tobago	14
Ruta chalepensis L.	1, 6, 12, 15, 16	Aerial parts, leaves	1.05	Argentina	3
Ruta graveolens L.	1, 6, 15	Leaves, aerial parts	0.70	Argentina, Brazil	3, 5, 7
Salicaceae					
Casearia sylvestris var. *lingua* (Cambess.) Eichler	15	-	0.21	Brazil	17
Salix alba L.	6	Stem	0.21	Argentina	3
Salix fragilis L.	6	Stalk	0.21	Argentina	3

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Salix humboldtiana Willd.	14	Stalk	0.35	Argentina	8
Santalaceae					
Jodina rhombifolia (Hook. & Arn.) Reissek	13	Aerial parts	0.21	Argentina	3
Sapotaceae					
Bumelia sartorum Mart.	13, 16	Bark	0.42	Brazil	15
Manilkara zapota (L.) P.Royen	-	-	-	Trinidad and Tobago	24
Pouteria sapota (Jacq.) H.E. Moore & Stearn	-	-	-	Trinidad and Tobago	24
Sideroxylon obtusifolium (Roem. & Schult.) T.D.Penn.	14	Aerial parts, bark, root	0.35	Argentina	8
Schizaceae					
Anemia tomentosa (Savigny) Sw.	15	Foliage	0.21	Argentina	3
Scrophulariaceae					
Scoparia dulcis L.	9	-	0.21	Brazil	15
Verbascum thapsus L.	10	-	0.28	Argentina	3
Simaroubaceae					
Quassia amara L.	1, 11	Leaves	0.49	Brazil	4, 16
Solanaceae					
Capsicum annuum L.	11, 18	Leaves, fruit	0.42	Argentina, Trinidad and Tobago	3, 13
Capsicum chacoense Hunz.	13	Fruits	0.21	Argentina	8
Capsicum frutescens L.	9	Fruit	0.21	Brazil	15, 21
Cestrum thyrsoideum Kunth	1, 15	Leaves	0.42	Argentina	3
Lycopersicon esculentum Mill.	2, 11	Fruit	0.42	Brazil	15
Nicotiana glauca Graham	15	Leaves	0.28	Argentina	3
Nicotiana tabacum L.	1, 15, 18	Leaves	0.77	Brazil, Argentina, Trinidad and Tobago	1, 3, 5, 8
Physalis viscosa L.	18	Aerial parts	0.21	Argentina	8
Solanum aridum Morong	18	Aerial parts	0.21	Argentina	8
Solanum mauritianum Scop.	11	Leaves	0.21	Brazil	22

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Solanum melongena L.	17	Fruit, bark	0.21	Brazil	9, 10
Solanum paniculatum L.	13, 17	Root, bark	0.49	Brazil	15
Solanum sisymbriifolium Lam.	11	Leaves	0.21	Brazil	22
Sterculiaceae					
Cola nitida (Vent.) Schott & Endl.	15	Seeds	0.21	Trinidad and Tobago	1
Guazuma tormentosa Kunth.	10	Bark	0.21	Brazil	16
Theobroma cacao L.	15	Fruits	0.21	Trinidad and Tobago	2
Ulmaceae					
Celtis chichape (Wedd.) Miq.	10, 18	Leaves	0.42	Argentina	8
Urticaceae					
Cecropia pachystachya Trécul	17	-	0.21	Brazil	17
Laportea aestuans (L.) Chew	17	-	0.21	Trinidad and Tobago	2
Parietaria debilis G. Forst.	18	Aerial parts	0.21	Argentina	8
Urtica urens L.	12	Aerial parts	0.21	Argentina	3
Verbenaceae					
Aloysia gratissima (Gillies & Hook.) Tronc.	14, 15	Leaves, aerial parts	0.49	Argentina	3
Aloysia polystachya (Griseb.) Moldenke	10	Aerial parts	0.21	Argentina	8
Lippia alba (Mill.) N.E. Br. ex Britton & P.Wilson	10 ,18	Aerial parts, leaves	0.99	Brazil	4, 9, 10, 15
Lippia turbinata Griseb.	1, 10, 13, 15	Aerial parts, leaves	0.92	Argentina	3
Stachytarpheta jamaicensis (L.) Vahl	1, 18	Leaves	0.42	Trinidad and Tobago	2, 13
Verbena hispida Ruiz & Pav.	-	-	-	Bolivia	27
Viscaceae					
Phoradendron hieronymi Trel.	14	Aerial parts	0.35	Argentina	8

(continued)

Table 14.1 (continued)

Family/species	Categories of diseases (see Table 3)	Part or by-product used	IR	Country	Bibliographic source[a]
Phoradendron liga (Gillies ex Hook. & Arn.) Eichler	14	Aerial parts	0.35	Argentina	8
Vochysiaceae					
Qualea grandiflora Mart.	3	-	0.21	Brazil	17
Xanthorrhoeaceae					
Aloe arborescens Mill.	11	Leaves	0.21	Brazil	7
Zingiberaceae					
Aframomum melegueta K. Schum.	18	Seeds	0.21	Trinidad and Tobago	1
Alpinia speciosa (Blume) D. Dietr.	9	Flowers	0.21	Brazil	15
Costus scaber Ruiz & Pav.	15	Stalk	0.21	Trinidad and Tobago	1
Curcuma longa L.	14, 15	Rhizome	0.42	Trinidad and Tobago	2, 13
Hedychium coronarium J.Koenig.	10	-	0.28	Brazil	17
Renealmia alpinia (Rottb.) Maas	1	Leaves	0.21	Trinidad and Tobago	1, 19
Zingiber officinale Roscoe	15, 18	Root	0.85	Brazil	15
Zygophyllaceae					
Bulnesia sarmientoi Lorentz ex Griseb.	9	Core	0.21	Argentina	8
Larrea divaricata Cav.	12, 13, 14, 17, 18	Aerial parts	1.05	Argentina	3
Porlieria microphylla (Baill.) Descole, O'Donell & Lourteig	6, 10, 15, 17	Leaves, mucilage, inflorescence, fruit, aerial parts	0.92	Argentina	3

[a] Bibliographic source: (1) Lans et al. (2001), (2) Lans and Brown (1998a), (3) Martínez and Luján (2011), (4) Ritter et al. (2012), (5) Silva et al. (n.d.), (6) Venero (2006), (7) Antonio et al. (2015), (8) Scarpa (2000), (9) Almeida et al. (2006), (10) Andrade (2002), (11) Araújo et al. (2011), (12) Barboza et al. (2010), (13) Lans et al. (2006), (14) Lans et al. (2007), (15) Marinho et al. (2007), (16) Monteiro et al. (2011a, b), (17) Viu and Viu (2011), (18) Barboza et al. (2007), (19) Lans and Brown (1998b), (20) Bussmann and Sharon (2006), (21) Sikarwar (1997), (22) Avancini and Wiest (2008), (23) Schuch (2007), (24) Lans (1996), (25) Faria et al. (2005), (26) Agra et al. (2007), (27) Carretero (2005), (28) López (1998), (29) De-la-Cruz et al. (2007), (30) Almeida et al. (2007), (31) Santos et al. (2017)

The recorded medicinal plants were indicated for the treatment of 177 diseases or conditions in nonhuman animals in Latin America, representing all 18 categories of diseases of the ICD (Table 14.3). As highlighted by Orwa (2002), traditional medicinal treatments involve the use of products such as plants, animal parts, and minerals, but medicines of vegetable origin are the most widely used throughout the world. The species with the greatest relative importance (IR) – that is, the species with the highest number of indications to treat different types of diseases and conditions recorded in our research – was *Chenopodium ambrosioides* L., which was indicated for the treatment of diseases of the circulatory, respiratory, genitourinary, osteomuscular, and digestive systems.

The recorded plants were used in various ways in ethnoveterinary practices, from the whole plant to just parts. The present review recorded a wide variety of plant products used as medicines in traditional veterinary medicine, such as leaves, aerial parts in general, roots, bark, fruits, seeds, bulbs, exudates, resin, flowers, latex, pods, inflorescences, nuts, spores, shoots, stems, tubers, fruit oil, mucilage, and thorns/spines. Decoction is one of the most widespread forms of use of plants for medicine, which consists of boiling a plant in a liquid to extract its active ingredients. For example, the decoction of leaves and peels of *Acacia aroma* Gillies ex Hook. & Arn. produces a product that is used for the treatment of wounds in Argentina and Bolivia. Topical use is also quite common, as in the case of *Mangifera indica* L., whose exudates are used as cicatrizant in Brazil.

Pharmaceutical industries have benefited greatly from traditional knowledge of the medicinal properties of plants, which has contributed to the development of numerous medicines throughout the world (Ferreira and Pinto 2010). Many of the plants used in ethnoveterinary therapies have had their effectiveness scientifically substantiated. For example, Kalayou et al. (2012) analyzed the antimicrobial activity of medicinal plants traditionally used in veterinary treatments in Ethiopia and demonstrated the antibacterial efficacy of *Nicotiana tabacum* L. against Gram-positive bacteria. Likewise, the antihelminthic properties of *Allium sativum* and *Zingiber officinale* were verified by Iqbal et al. (2001), who proved its efficacy in the control of worms.

14.3.2 Zootherapeutics in Ethnoveterinary Medicine

Although fewer animal species were reported than plant species, they too are used as sources of remedies by ethnoveterinary medicine practitioners in Latin America. The present bibliographic review revealed that 61 species of animals are used as sources of drugs for ethnoveterinary treatments in the two Latin American countries for which there are published surveys about these practices: Brazil and Peru (Table 14.2). Sixty-one species of animals are distributed among 48 different families. Considering the limited number of studies on the use of animals, and the fact they have been carried out in only two countries, this number of species certainly underestimates the actual use of animals in traditional veterinary treatments in Latin America.

Table 14.2 Species of animals used in ethnoveterinary medicine in Latin America

Family/species	Categories of diseases (see table 3)	Part or by-product used	IR	Country	Bibliographic source∗
INSECTS					
Apidae					
Apis melifera Linnaeus, 1758	6,17	Honey	0.27	Brazil	1, 2
Melipona subnitida Ducke, 1910	6,17	Honey	0.27	Brazil	1, 2
Partamona seridoensis Pedro & Camargo, 2003	1, 6, 11, 14, 15, 17	Honey, pollen	1.1	Brazil	1, 2
Scapitotrigona sp.	6	Honey	0.13	Brazil	1, 2
Trigona spnipes Fabricius, 1793	4	Honey	0.13	Brazil	3, 4
Bothriuridae					
Bothriurus asper Pocock, 1893	11	Sting	0.19	Brazil	1, 2
Buthidae					
Rhopalurus rochai Borelli, 1910	11	Sting	0.19	Brazil	1, 2
Gryllidae					
Acheta domesticus (Linnaeus, 1758)	-	-	-	Brazil	5
Termitidae					
Nasutitermes corniger (Motschulsky, 1855)	1	Whole animal	0.13	Brazil	1, 2
Vespidae					
Polistes canadensis (Linnaeus, 1758)	11	Sting	0.13	Brazil	6, 7
CRUSTACEANS					
Astacidae					
Astacus sp.	18	Whole animal	0.13	Peru	10
Palaemonidae					
Cryphiops caementarius (Molina, 1782)	-	-	-	Peru	9
ECHINODERMS					
Echinasteridae					
Echinaster brasiliensis Müller and Troschel, 1842	9	Whole animal	0.13	Brazil	10
Echinaster echinophorus (Lamarck, 1816)	9	Whole animal	0.13	Brazil	10
Luidiidae					
Luidia senegalensis (Lamarck, 1816)	9	Whole animal	0.13	Brazil	10
Oreasteridae					
Oreaster reticulatus (Linnaeus, 1758)	9	Whole animal	0.13	Brazil	10

(continued)

Table 14.2 (continued)

Family/species	Categories of diseases (see table 3)	Part or by-product used	IR	Country	Bibliographic source*
FISHES					
Curimatidae					
Prochilodus sp.	16	Fat	0.13	Brazil	7, 11
Electrophoridae					
Electrophorus electricus (Linnaeus, 1766)	15	Fat	0.13	Brazil	1, 2
Erythrinidae					
Hoplias malabaricus (Bloch, 1794)	6, 18	Fat	0.42	Brazil	1, 2
Megalopidae					
Megalops atlanticus Valenciennes, 1847	-	-	-	Brazil	12
Syngnathidae					
Hippocampus reidi Ginsburg, 1933	9	Whole animal	0.13	Brazil	10
AMPHIBIANS					
Bufonidae					
Rhinella jimi (Stevaux, 2002)	15	Fat	0.13	Brazil	13
Rhinella schneideri (Werner, 1894)	11, 15, 16	Fat, viscera	0.48	Brazil	1, 2
REPTILES					
Alligatoridae					
Caiman latirostris (Daudin, 1802)	15, 16	Fat, skin	0.27	Brazil	1, 2
Boidae					
Boa constrictor Linnaeus, 1758	1, 9, 10, 11, 12, 15, 16, 17	Fat	1.39	Brazil	3, 1, 2
Chelidae					
Phrynops geoffroanus (Schweigger, 1812)	1, 7, 9, 11, 12, 14, 16, 17	Fat	1.57	Brazil	6, 7, 14, 1, 2, 11, 15
Cheloniidae					
Caretta caretta (Linnaeus, 1758)	-	-	-	Brazil	12
Iguanidae					
Iguana iguana (Linnaeus, 1758)	6, 9, 11, 12, 16, 17	Fat, skin, bones	1.28	Brazil	6, 7, 14, 1, 2, 11, 15
Teiidae					
Salvator merianae Duméril & Bibron, 1839	1, 6, 9, 10, 11, 15, 16, 17, 18	Fat, skin	1.57	Brazil	14, 1, 2, 11, 15
Testudinidae					
Chelonoidis carbonarius (Spix, 1824)	16	Fat	0.13	Brazil	1, 2
Tropiduridae					
Tropidurus hispidus (Spix, 1825)	16	Viscera	0.27	Brazil	1, 2, 15

(continued)

Table 14.2 (continued)

Family/species	Categories of diseases (see table 3)	Part or by-product used	IR	Country	Bibliographic source∗
Viperidae					
Crotalus durissus Linnaeus, 1758	6, 9, 11, 12, 15, 17, 18	Fat, rattle, skin	1.22	Brazil	6, 7, 14, 13, 1, 2, 11, 15
BIRDS					
Cariamidae					
Cariama cristata (Linnaeus, 1766)	17	Fat	0.13	Brazil	1, 2
Cathartidae					
Coragyps atratus (Bechstein, 1793)	1	Feathers	0.13	Brazil	1, 2
Ciconiidae					
Vultur gryphus Linnaeus, 1758	18	Meat	0.13	Peru	10
Corvidae					
Cyanocorax cyanopogon (Wied, 1821)	1, 18	Feathers, whole animal	0.19	Brazil	1, 2
Meleagrididae					
Meleagris gallopavo Linnaeus, 1758	11, 15, 16	Fat	0.62	Brazil	6, 1, 2, 15
Phasianidae					
Gallus gallus domesticus Linnaeus, 1758	1, 4, 6, 7, 9, 11, 12, 15, 16, 17	Eggs, fat, gizzard membrane	1.77	Brazil	6, 7, 14, 1, 2, 11, 15
Picidae					
Colaptes rupicola d'Orbigny, 1840	18	Feathers, meat	0.13	Peru	10
Rheidae					
Rhea americana (Linnaeus, 1758)	11, 12, 15, 16	Fat	0.62	Brazil	1, 2
Tinamidae					
Nothura maculosa cearensis Naumburg, 1932	15	Feathers	0.19	Brazil	6, 7, 14, 1, 2, 11, 15
MAMMALS					
Agoutidae					
Cuniculus paca (Linnaeus, 1766)	15	Bile	0.13	Brazil	1, 2
Bovidae					
Bos taurus Linnaeus, 1758	1, 4, 9, 11, 12, 14, 15, 16, 17, 18	Skin, milk, milk fat, cream of milk, homemade butter, horns	2	Brazil	6, 7, 14, 1, 2, 11, 15
Capra hircus Linnaeus 1758	11, 15	Fat, skin, homemade butter	0.42	Brazil	1, 2
Ovis aries Linnaeus, 1758	9, 11, 12, 15, 16, 17, 18	Castrated lamb fat, skin, horns	1.60	Brazil	6, 7, 14, 1, 2, 11, 15

(continued)

Table 14.2 (continued)

Family/species	Categories of diseases (see table 3)	Part or by-product used	IR	Country	Bibliographic source*
Canidae					
Canis lupus familiaris Linnaeus, 1758	14, 18	Head	0.27	Brazil	1, 2
Cerdocyon thous (Linnaeus, 1766)	9, 11, 12, 14, 15, 16, 17, 18	Blood, fat, skin, tail	1.22	Brazil	6, 7, 14, 1, 2, 11, 15
Caviidae					
Cavia aperea Erxleben, 1777	11	Fat	0.13	Brazil	1, 2
Kerodon rupestris F. Cuvier, 1825	9, 12, 18	Fat, meat	0.48	Brazil	1, 2
Cervidae					
Mazama gouazoupira (G. Fischer [von Waldheim], 1814)	12, 15	Fat, horns	0.33	Brazil	1, 2, 15
Dasypodidae					
Dasypus novemcinctus Linnaeus, 1758	15	Skin plaques, fat	0.19	Brazil	1, 2
Euphractus sexcinctus (Linnaeus, 1758)	11, 15	Fat	0.27	Brazil	6, 7, 14, 1, 2
Erethizontidae					
Chaetomys subspinosus (Olfers, 1818)	-	-	-	Brazil	52
Coendou insidiosus Lichtenstein, 1818	-	-	-	Brazil	52
Felidae					
Leopardus tigrinus (Schreber, 1775)	10, 16, 17, 18	Fat, skin, tail	0.56	Brazil	1, 2
Puma yagouaroundi (É. Geoffroy Saint-Hilaire, 1803)	10, 16, 17, 18	Fat, skin, tail	0.56	Brazil	1, 2
Hominidae					
Homo sapiens Linnaeus, 1758	6, 15, 18	Milk, urine	0.42	Brazil	6, 1, 2, 15
Mustelidae					
Conepatus semistriatus (Boddaert, 1785)	12, 18	Meat, bones	0.27	Brazil	1, 2
Myrmecophagidae					1, 2
Tamandua tetradactyla (Linnaeus, 1758)	18	Skin	0.13	Brazil	1, 2
Procyonidae					1, 2
Procyon cancrivorus (G. [Baron] Cuvier, 1798)	18	Skin, tail	0.13	Brazil	1, 2
Suidae					
Sus scrofa domesticus Erxleben, 1777	1, 6, 11, 12, 15, 16, 18	Fat	1.1	Brazil	6, 7, 14, 1, 2, 11, 15

*Bibliographic source: (1) Souto et al. (2011a), (2) Souto et al. (2011b), (3) Costa-Neto (1999), (4) Costa-Neto et al. (2006), (5) Lenko and Papavero (1996), (6) Barboza et al. (2007), (7) Barboza et al. (2010), (8) Froemming (2006), (9) Valdizán and Maldonado (1922), (10) Alves et al. (2009), (11) Souto et al. (2012a), (12) Costa-Neto (2001), (13) Ferreira et al. (2009), (14) Confessor et al. (2009).

Mammals were the animal group most reported as a source of drugs for ethnoveterinary treatments (20 species, 32.28%), followed by insects (10 species, 16.39%), birds and reptiles (9 species, 14.75% each), fish (5 species, 8.19%), echinoderms (4 species, 6.55%), and amphibians and crustaceans (2 species, 3.27% each). The tendency to use vertebrates in ethnoveterinary practices is similar to the panorama documented by several studies for human popular medicine (Alves 2009; Alves et al. 2007; Barboza et al. 2007; Begossi et al. 1999; Souto et al. 2011a; Castillo and Ladio 2018; Martinez 2013), reflecting the existence of closely intertwining relationships between nonhuman animal ethnomedicine and human ethnomedicine (Souto et al. 2013).

In addition to using an entire animal, a great variety of products of animal origin have been documented as being used as remedies in ethnoveterinary treatments, including honey, lard, viscera, leather, bones, rattles, feathers, meat, eggs, bile, mile and its derivatives, horns, sebum, tail, skull, animal carcass, dermal plaques, and urine (Table 14.2). Lard is the most used natural remedy of animal origin and is reportedly extracted from 27 of the 61 species recorded in the present review (44.26%). The wide use of lard in ethnoveterinary treatments was also recorded by Souto et al. (2011a, b) in their study on zootherapeutics of veterinary importance in a region of Brazil. This trend has also been observed in other regions of the world, such as India (Mahawar and Jaroli 2008), where lard is used for the treatment of various diseases of both nonhuman animals and humans.

The zootherapeutic products recorded in this review were associated with the treatment of 46 diseases and sicknesses of nonhuman animals in Latin America, representing 13 of the 18 different ICD categories. The majority of zootherapeutic species (55.73%, $n = 34$) were reported to have multiple uses for various therapeutic treatments. Some illustrative examples include the lizard *Salvator merianae* (Duméril and Bibron, 1839), whose products were indicated to treat 14 animal diseases in Brazil, and *Ovis aries* (Linnaeus 1758) and *Gallus gallus domesticus* (Linnaeus 1758), which were indicated for the treatment of 16 animal diseases in Brazil. The species with the highest relative importance value – that is, the species indicated for the largest number of ethnoveterinary treatments – was *Bos taurus* (Linnaeus 1758) (IR = 2), which was reported to be used in the treatment of 17 diseases of 12 different ICD categories (Table 14.3).

14.4 Final Considerations

The results of the present study show that a large number of biological species are used in ethnoveterinary treatments in Latin America. These data reflect the existence of broad knowledge regarding the use of natural resources in traditional veterinary medicine. As expected, a much larger number of plant species ($n = 363$) than animal species ($n = 61$) were reported to be used for these purposes, reflecting a trend also observed in traditional human medicine. In addition to being more intensely used in traditional medicinal practices, plants have also received greater

Table 14.3 Categories of animal diseases treated with ethnoveterinary products in South America

Categories	Diseases and illnesses
1. Infectious and parasitic diseases	Mastitis, tick fever, helminthes, endoparasites, myiasis, ectoparasitoses, mycosis furunculosis, smallpox, canine distemper, gastrointestinal nematodes, antibiotic, foot-and-mouth disease, parvovirose, amebiasis, giardiasis, malaria, rage syndrome, protozoic, leishmaniasis, antimicrobial
2. Neoplasms	Tumors
3. Blood disorders and immune disorders	Hematuria, increase blood count, anemia
4 - endocrine, nutritional, and metabolic diseases	Diabetes, weakness, dehydration, lack of appetite, increase feed
5. Mental and behavioral disorders	Domestication of angry animals, tranquilizer, make animals more ferocious, sedative
6. Eye diseases and appendages	Blindness, eye problems, eye injuries, ocular inflammation, tear stains ("manchas de lágrimas"), cataract, ocular injuries, conjunctivitis
7. Ear diseases	Ear diseases, inflamed ear
8. Diseases of the circulatory system	Hemorrhoids, hemorrhage, heart diseases, liver diseases, adenite
9. Diseases of the respiratory system	Coryza, asthma, tuberculosis, throat problems, bovine malignant catarrhal fever, catarrh, pneumonia, cough, expectorant, lung and gill diseases, cold, bronchitis
10. Diseases of the digestive system	Stomach ache, intestinal infections, intestinal disorders, cramps, gastritis, diarrhea, indigestion, constipation, abdominal pain, stomach gas, ulcers, intoxications, enteritis, dysentery
11. Skin diseases	Nodules, boils, cutaneous habronemiasis (wounds caused by infestation of *Habronema muscae* larvae), scabies, eczema, rash, skin diseases, dermatophytosis, allergic contact dermatitis, pimples on the skin, anhidrosis, pruritus, hair problems, itch, irritation, keratitis, canine scab ("rabuja")
12. Osteomuscular diseases	Rheumatism, omphaloarteritis, arthritis, bone fractures, spinal problems, muscle aches, tendon problems, musculoskeletal disorders
13. Diseases of the genitourinary system	Kidney problems, cervicitis, vaginitis, diuretic, kidney stones, urinary infection, difficulty urinating, genital infections, anuria
14. Pregnancy, childbirth, and puerperium	Uterine prolapse, placenta retention, uterine atony, oxytocic, abortive, breast-feeding, udder care, labor pains, remove dead piglets from the uterus, postpartum cleaning
15. Injury and poisoning	Wounds, injuries, snake bites, sprain, poisoning, scorpion sting, insect bites, incision
16. External causes of mortality	Wounded with sharp object ("estrepe'), burns, injured with thorn, trauma, bottleneck, bruises, blows

(continued)

Table 14.3 (continued)

Categories	Diseases and illnesses
17. Unclassified symptoms and signs	Swelling, inflammations, pain, healing, vomit, fever, hypothermia
18. Unspecified diseases and conditions	Lactation, cracks in livestock hooves, bad weather ("mal do tempo"), evil eye ("mau olhado"), protection against attacks by other animals (snakes, bats), sexual appetite, repellent, unwell, purgative, treatment of castrated cattle, bathe dogs, make the skin of the rooster greasy, reduce the appetite of chickens, sunshine on horses, rod used to cover goat horns after tick fever treatment, alopecia, bleeding gums, diaphoretic, sad evil disease ("mau triste"), contraceptive, to hunt hunting dogs, improve performance, water belly (barriga d'água), swine fever ("batedeira de leitão"), wash the nose of dogs, hair ball, weak smell, given to the pigs to lie on top, bad smell, emetic, antiseptic, compaction

attention from researchers and, thus, are much more studied in this regard than animals, further accentuating the difference in usage.

Ethnoveterinary medicine represents an important alternative for nonhuman animal health in Latin America, mainly because of the abundant rural populations in the region living in poverty with limited access to the medicines used in conventional veterinary medicine. In this way, the great abundance of natural resources that can be extracted from a rich biodiversity favors their use by traditional populations that depend on these resources to guarantee the health of their animals. The use of resources extracted from nature to treat diseases in humans and their animals is an ancient tradition widely disseminated in traditional communities. The vast biological and cultural diversity of Latin America is reflected in a vast network of ethnoveterinary knowledge. In spite of its importance, the literature on ethnoveterinary practices in Latin America is still scarce and restricted to a few countries, making it necessary to carry out additional studies to ensure the dissemination and perpetuation of this knowledge.

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Chapter 15
Local Practice of Cattle Farming and Ethnoveterinary Medicine in Estonia: Case Study of Saaremaa and Muhumaa

Raivo Kalle and Marko Kass

Keywords Estonian ethnoveterinary · Estonian dairy cattle history · Animal-keeping ritual · Pastoral grazing · Saaremaa and Muhumaa · Folk calendar in cattle keeping

15.1 Introduction

Cattle have been raised in Estonia since the Stone Age (which lasted in the territory of present-day Estonia until the beginning of the second millennium B.C.), when tribes of the Corded Ware culture arrived in this area together with the first domesticated cattle. The general transition to cattle raising took place in Estonia during the Bronze Age (1800–500 B.C.) (Mägi 2003); and thus both cattle raising and dairy farming have long traditions in Estonia. However, to date there have been no summary articles specifically dealing with the traditional or local rearing and treatment of cattle. Potential is seen in implementing experiences gained in the traditional treatment of animals, especially those with herbs, in modern organic cattle farming, but as yet no veterinary phytotherapy products have reached the market. Although knowledge about the effects of herbs can be obtained from ethnoveterinary medicine,

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Fig. 15.1 Location of the Estonian islands of Saaremaa and Muhumaa

ethnoveterinary practices have been investigated mainly in Southern Europe (Mayer et al. 2014). In Estonia different plant products have been successfully tested in the control of pig parasites (Mägi and Sahk 2003; Mägi et al. 2006), and therefore there is the potential to replace synthetic medications in organic farming. This article is the first to explore in depth the topic of Estonian ethnic veterinary medicine and provide a more thorough overview of one Estonian region – the islands of Saaremaa and Muhumaa (Fig. 15.1).

Saaremaa, which is located in the Baltic Sea, is the largest island in Estonia, at 2673 km^2. Due to its maritime climate and the versatility of the soil, Saaremaa has the greatest number of plant species in all of Estonia. The landforms are relatively low and flat, and approximately half of the island is currently covered by forest. The soil is nutrient poor, and therefore people have been more involved in cattle farming than growing crops. Presently, the island has approximately 33,000 residents (https://et.wikipedia.org/wiki/Saaremaa). Muhumaa is a smaller island, at 198 km^2, located next to Saaremaa, and it shares a similar natural environment. Currently there are more than 1600 residents on the island (https://et.wikipedia.org/wiki/Muhu).

15.1.1 General Collection of Local Ethnoveterinary Data in Estonia

The first data regarding traditional ethnoveterinary medicine was collected along with general trends in folklore. Pastor Jakob Hurt (1839–1907), who published his public calls in local newspapers, initiated this trend in 1888. The active village residents welcomed his idea across Estonia, and many became his collaborators in collecting folklore. Hurt provided the focus for the following era – to collect and study mainly lyrical folklore – and he also set the general classification of folklore, where ethnoveterinary medicine was categorized under religion and customs.

Institutions of historical memory such as the Estonian National Museum (ENM) and the Estonian Folklore Archives (EFA), which were created at the beginning of the twentieth century, also began collecting folklore with the help of professional folklorists, and also by publishing general calls to the public, as was done by Jakob Hurt. The ENM began paying more attention to ethnographic materials, and they have therefore published and distributed numerous questionnaires regarding the life of domestic animals (e.g. Linnus 1981; Jaagosild 1963, 1964; Ridala 1946, etc.). But these collection campaigns have been more for just gathering data for the collection, and more thorough analyses have been left for future researchers. Therefore, as museum employees traditionally have not been researchers in the field themselves, often the interview plans have been deficient. Only short articles in encyclopaedias (e.g. Pärdi 2008) have been published from this material, and no in-depth studies have been carried out. Inadequacies of the thematic material include the extremely uneven quality of both the answers and the extent of regional contributions, and also the one-sidedness and inclination of the material (as qualitative in-depth additional questions asked during interviews were not implemented in the case of written correspondence). Following Hurt's example, the EFA continued collecting oral folklore with an emphasis on lyric materials, and thus ethnoveterinary medicine was not emphasized as a topic. If on rare occasions it was collected, it was left untouched as material for future research. This topic was not studied directly, but only sometimes indirectly, for example, in association with holiday traditions or religious rituals. The practical value of the material (e.g. how an animal was treated specifically) was not considered important, but rather only the presentation or writing of the story. Also thematic collections of folkloric texts aimed at the public have been issued, collecting the most beautiful stories by the best correspondents (e.g. Loorits 2001).

The largest collection of folkloric plant usage in Estonia was collected by the teacher and botanist Gustav Vilbaste (1885–1967). His work therefore remains the most important early source pertaining to plant usage. Although he planned to issue a five-volume collection about the use of plants, only the first two volumes were ultimately published (Vilberg 1934, 1935). He also selectively noted the uses of plants employed in ethnoveterinary medicine in his monograph of plant names (Vilbaste 1993). In this work, the Vilbaste monograph has been used to identify the folk plant names and folk animal diseases names.

15.1.2 Folklore Collection of the Academic Veterinary Association

The most thorough interview plan on ethnoveterinary medicine in the early days of research was prepared in 1912 by veterinarian Johannes Kool (Kool 1912), who also initiated a general call for people to participate. World War I interrupted the collecting work. It is known that by the year 1920, he had received responses from 21 persons (Kool 1920), but no traces of the data have been discovered up to today. Still, his lasting contribution is that his interview plan was later taken as a basis for the collection activities of the Academic Veterinary Association (AVA) (in Estonian *Akadeemiline Loomaarstiteaduslik Selts*, ALS (1928–1934)). However, the collection method of the AVA differed greatly from that of memory institutions and also Kool. Firstly, the interview plan was very professional; secondly, correspondents were not used, but rather fieldwork was carried out in villages by veterinary students knowledgeable on the topic; and thirdly, the collection was systematic, i.e. it attempted to cover the entire territory of Estonia uniformly (although more emphasis was given to bordering counties), which also allows studies to be conducted according to region. Over the course of 6 years (1928–1934), the fieldwork projects of eight grantees were funded which resulted in the collection of more than 4000 pages (about A5 format), making this the largest thematic collection. Today, the collection is stored in the Estonian Folklore Archives of the Estonian Literary Museum (Tartu). Unfortunately, so far the material has not been thoroughly analysed (for more on the history of ethnoveterinary research, see Ernits 2001).

The region for the case study of this article was limited to the islands of Saaremaa and Muhumaa. In this region, fieldwork was conducted by the Vassili Grünthal (as of 1930 named Ridala; 1906–1985) who became later veterinary professor at the University of Tartu. Grünthal himself was also born and raised in Muhu Island. During the summer of 1928, he interviewed a total of 23 people from Muhumaa and 16 people from Saaremaa. The answers have been gathered into volume 1 of the AVA collection, totaling 735 pages. In 2014 and 2015, ethnobotanists Raivo Kalle and Renata Sõukand carried out ethnobotanical fieldwork in Saaremaa, during which 61 and 58 people were interviewed, respectively. The gathered material is stored in the Folklore Archives of the Estonian Literary Museum in the authors' collection (RR, Saaremaa (2014–2016)). The interviews also covered plants used in ethnoveterinary medicine, and these plants have been presented in comparison with the AVA plants (see more about the fieldwork in Sõukand and Kalle 2016; Kalle and Sõukand 2016).

15.2 Historic Ethnoveterinary Medicine in Saaremaa and Muhumaa

15.2.1 Cattle Farming and the Traditional Calendar

In addition to questions regarding the (medical) treatment of animals, Vassil Grünthal also asked questions about maintaining the animals' wellbeing on a daily basis as well as according to the traditional calendar. Here wellbeing signifies what had to be done to prevent animals from falling ill. The answers show that the most important day for cattle farmers used to be the day cattle were let out of their barn for the first time in the spring (called *karjalaskepäev*). Generally in Estonia that day has been 1 April. But considering that until January 1918, Estonia used the Julian calendar, this indicates a date of 15 April according to the current Gregorian calendar. Yet, this day was more symbolic as the natural conditions were not suitable for letting cattle outdoors (too little grass in the pasture, fickle weather, etc.). In reality, the day of letting the cattle outdoors was celebrated along with St. George's Day (called *jüripäev*) on 23 April. The reason was that St. George's Day was important as the beginning of all springtime farm work. St. George, in whose honour the day is celebrated, was considered to be the patron saint of fields and cattle and was supposed to particularly protect cattle from wolves (Hiiemäe and Järv 2016). The answers in the questionnaire did not reveal whether "the day of letting the cattle out" referred to the calendar holiday or the day when cattle were actually let out of the barn for the first time. The latter is favoured by the fact that the AVA has a note from Muhumaa island that when letting the cattle outdoors for the first time, it was observed that it would not be on either Monday or Friday, which were considered unlucky days. It is specified that this tradition was followed more in manor barns. Hence, by 1928 the calendar tradition was replaced by a more logical option that was based on the weather.

As during the winter the animals were hidden from strangers' looks, they had to be protected from these people when being let out in the spring – there was a particular fear of "the evil eye" (called *kuri silm* or *kaetus* in Estonian). The charms and objects used against "the evil eye" were similar in both Saaremaa and Muhumaa. The most important of these was common salt, which was thrown behind the animals when they were walking to the pasture for the first time. Sprinkling salt into the tracks of the animals was also thought to keep the animals safe from wolf attacks during the summer. A second protective object was bread, which was fed to the animals with salt. It was believed that bread kept from Christmas or a special loaf baked on Shrove Tuesday had special powers.

On rare occasions, words usually spoken at christenings (Christian ceremony at which a baby is baptized) were read on that day to animals to ward off "the evil eye" and wolf attacks. But it was more common to ward off wolves by placing a soot-covered kettle log (a log on which the kettle is hung over a fire) on the doorstep of the barn so that the animals would step over it.

Fig. 15.2 Historical photograph of barn with cattle, Lümanda village, early twentieth century (https://arhiiv.saartehaal.ee/2009/03/17/lumanda-muuseum-sai-naituse-tegemiseks-toetust/)

To keep snakes from biting animals during the summer, the chest, nose or head (between the horns) of cows was rubbed with tar, or wood tar was put into their mouths with a wooden stick. It was thought that the smell of wood tar would keep snakes away. In order to prevent different foot ailments in animals during the summer, different iron tools such as an axe and a bar were put on the doorstep of the barn in the belief that if an animal steps over them, they would not get ill.

Another important period in the calendar began with Christmas (6 January in the Gregorian calendar) and ended with the Epiphany (called *kolmekuningapäev*). On Christmas Eve and New Year's Eve, there was the tradition to draw crosses with chalk above the windows and doors of the barn to protect animals. In the Sõrve Peninsula, on New Year's morning, crosses were circled, but in Muhumaa the crosses were made using soot on New Year's Day. There is a single mention of crosses also made on the Epiphany.

The archival texts did not include notes about traditions during the third most important period – Midsummer (called *jaanipäev*) – however, contemporary fieldwork revealed that flower wreaths were used to adorn the animals coming home from the pasture during that time. Whether this was done with the intention to ward off danger or illness is no longer known. A historical photograph of a traditional village barn with cattle is shown in Fig. 15.2.

15.2.2 Activities to Help Animals to Adjust to the Pasture and Stay There

For a new animal to adjust, there were several customs to observe on the day of purchase. According to custom, after the money was paid, the former owner was no longer allowed to pet the animal, whether it is a cow or a horse. It was traditional for the new master to take a handful of hay from the former owner's cart and to feed it to the animal upon arrival home. When the new owner got to their home gate with the animal, they placed their leather belt in front of the gate, and the animal had to step over it. This was thought to bind the animal to the new place.

Now and then a wooden stick or cattle whip was taken from the former home of the animal and put into the eaves of their new home upon arrival. Conversely, it was very common in Saaremaa and Muhumaa to take one, three or nine rocks from the former home of the animal and throw them into the well on arrival to their new home (barn). Sometimes the stones were passed around the animal's head three times before throwing them into the well. At the same time, there is a note that mentions three rocks taken from the place of purchase were tapped on the animal and then left behind at the same place. The well was an important place in the home yard, and thus three turns around the well, preferable in a counterclockwise direction, were taken with the animal upon arrival home. A similar action was taken when an animal fell ill at home, after which it was given a bucket of water to drink. If possible, the water was brought from a health-giving spring. When a new animal was let out the pasture with the other animals, they were all given pieces of bread from the same loaf, which were sometimes covered with the saliva of the new animal.

To keep animals in the pasture during the summer and to keep them from running away, the first cattle whip used on the day when the animals were let out for the first time was attached to the house or the eaves in the evening. Similarly, during birth of an animal, the keys of the barn or house were put into the first hot drink water so that the animal would keep to their home.

15.2.3 Changes in the Quality of the Raw Milk and How to Improve It

Up to the end of the nineteenth century, raw milk was mainly kept in wooden containers. Starting from the beginning of the twentieth century, metal milk cans were also used. Accordingly, the older people interviewed in 1928 still remembered the time when wooden milk containers were used: the archival texts mention boiling the milk containers in hot water in such instances. Sometimes dried grass was also put into the hot water. It was also believed to help if the milk containers were washed with ash lye and dried in the sun. In earlier times, when the cows were in the barn during the winter, they did not provide milk as this was the time of pregnancy. The milking period was during the summer. As raw milk quickly spoils, it needs good conditions for preservation, which were often not available in the countryside. Raw milk was kept either in the well or in a cool cellar. Sour milk, unlike fresh milk, was drinkable for many days.

It was thought that any changes in milk when storing it, such as the milk becoming sticky, spoiled, hardened, etc., were the result of witchcraft. Both Saaremaa and Muhumaa had similar activities to prevent this from happening. It was widely common to smoke the milk containers with scraps from the yard (grass, leaves, twigs, etc.) or old rags. The best things to use for this were the trash from the yard of the person or the clothes of the person who was considered to be responsible for spoiling the milk. But if these were not available, the trash from the home yard and even hay from the pigsty or old sails were considered suitable. In some parts, the milk equipment was later washed with ash water, or the water was given to the animal to drink. Washing milk containers with ashes was also recommended in the early literature (Ollino 1897), and the best to use were ashes from leafy trees, particularly birches (*Betula* spp.) (Ottenson 1932). If it was thought that the milk had spoilt after a woman had stepped over the milking bucket, the containers were smoked with the threads of the woman's apron.

If the taste of the raw milk changed and it tasted, for example, like a grinding stone or grinder, it was thought that this occurred because the milk containers had been used to take water to the water container under the grinding stone. In order to prevent such a change in the taste of milk or to remove it, a grinding stone was put at the bottom of the animal's drinking dish, and the animal was given this water to drink right after giving birth. Also a grinding stone or chips from the stone were put into the water when washing milk containers for the same purpose.

15.2.4 Supernatural Illnesses and Their Treatment

It was previously thought that supernatural illnesses were caused by *lendva* – a witching arrow sent by an evil person either with words or the wind, with which a sudden illness or attack was directed towards the animal. In the medical literature, "attack", "witching arrow" and "sudden illness" have been identified as anthrax, a severe infection caused by the bacteria *Bacillus anthracis.* Its spores are particularly resilient to external impacts, and grass-eating animals ingest it with fresh grass or feed (Sumberg et al. 1941).

As the illness comes on suddenly, in Saaremaa and Muhumaa, it was cured with gunpowder, which also causes a sudden reaction. Gunpowder was either fed to the sick animal with water or given dry with salt. Infrequently, a gun loaded with only gunpowder was shot once to the left and another time to the right of the animal. It was also common to smoke the animal by different means. For example, the gunpowder was lit and the animal's head covered with cloth so that it would inhale the smoke; three matches were lit in a row under the animal's nose; or dust was gathered from room corners, crossroads, the door or the gate and then smoked. Also, the traditional medicines asafoetida (*Ferula assa-foetida*) and frankincense (*Boswellia* spp.) were brought from the pharmacy and smoked under the animal's nose. Another method involved drawing blood from the tail or ear of the animal and then feeding it to that animal, if necessary with bread.

Lice and other parasites on animals were also considered to be of supernatural origin or due to the "the evil eye". It used to be common in both Saaremaa and Muhumaa to take nine lice from an animal, to put them into a gun and then to shoot them into a northern wind, the forest or a body of water. There are also notes in the archival texts that mention the practice of putting nine lice into a hole in a log, which was then closed, and the log thrown into the furnace. There were other ritual activities such as swiping the animal three times with an old broom.

15.3 Herbs, Mushrooms and Mosses Used Against Cattle Illnesses and in Wellbeing Rituals in Saaremaa and Muhumaa

15.3.1 List of Herbs of the AVA

Certainly, the folklore texts do not cover the totality of the situation and knowledge, as they constitute the results of only one expedition. As there are no earlier lists of herbs used in Estonian ethnoveterinary medicine, the list of the AVA can now be compared with recently gathered data, and these differences are outlined in Table 15.1 and discussed below.

The use of nettle (*Urtica dioica*) to feed cows has been recommended for more than a century (Jannau 1857, Wöhrmann 1930s, and others), and this practice was also mentioned by informants during the recent fieldwork. Therefore, it can be said for certain that although the archival texts do not specify this, the herb was also used as feed during those periods. The literature recommended the use of nettle as it increases milk production and improves the animal's overall health. The use of clover (*Trifolium* spp.) in order to increase milk production was also well-known, today as well as in the past (e.g. Jannau 1857 and others). This plant was mainly sown on pastures and given as fodder. A typical scene of Saaremaa pasture is presented in Fig. 15.3.

It has always been a tradition to make leaf brooms for feeding animals in the wintertime in both Saaremaa and Muhumaa. These were mainly made for sheep, but they were also given to cows if there were excess brooms or if there was a lack of hay. The branches for the brooms were gathered by cutting off branches from a large tree or by chopping off brushwood. The branches bunched up were about 1.5 m tall, and these were kept in the hayloft of the barn. The interviewees told me that the animals liked to eat the leaves of ash (*Fraxinus excelsior*) and alder buckthorn (*Frangula alnus*) the most. The brooms were dried in a sheltered place under the eaves of buildings, and the dried brooms were kept in a hayloft or barn. The branches of coniferous trees such as spruce (*Picea abies*), pine (*Pinus sylvestris*) and more rarely juniper (*Juniperus communis*) were given mainly during late winter or early spring when there was a lack of hay or in the spring for vitamins. As these trees are evergreens, the branches were brought from the woods when necessary and not stored beforehand (see more from Kalle 2015). Although these species and usages were not recorded by the AVA, it can still be said that these trees or bushes were also fed to animals before.

Table 15.1 Plants used for ethnoveterinary medicine and animal wellbeing in Saaremaa and Muhumaa

Latin name (family)	Folk name	Purpose of use	Application
Achillea millefolium L. (Compositae)	Raudriiarohi, rauareierohi, rauareia, rauareia rohud, raudrohi[a]	(Fresh) wounds	Crushed leaves applied on wounds
		Diarrhoea in cows, stroke (apoplexia), blood enhancer[a]	Decoction given to drink
		Babesiosis	The herb is soaked in vodka or water and then the water or vodka is given to drink
		Bleeding from a wound	Plants soaked in spirits applied gently on a wound
Alchemilla xanthochlora Rothm. (Rosaceae)	Kõuerohi	Milk spoiling after cow terrified by thunder	Water infusion given to drink
Alnus spp. (Betulaceae)	Lepp	Put in colostrum	Bark put in milk so that the milk would stay fresh
		Babesiosis	An alder stick thrust into the ground where the cow urinated blood for the first time
		Spoiled milk	Cream from the milk put in a hole in an alder log and thrown into the furnace
Aloe arborescens Mill. (Xanthorrhoeaceae)	Aknauhakas	Burn wounds	Topical application of the juice
Artemisia absinthium L. (Compositae)	Koirohi	Abdominal diseases[a], constipation, diarrhoea in cows, cough	Decoction given to drink
		Stroke (apoplexia)	The herb is smoked under the animal's nose
	Suhkrupeet	Fresh wounds	The plant put on wounds
Beta vulgaris subsp. *vulgaris* var. *altissima* Döll (Amaranthaceae)		Postnatal period[a]	Beet syrup was given to strengthen cows
Betula spp. (Betulaceae)	Kask	Diarrhoea in cows	Water enriched with charcoal and ash was given to drink
		Ritual in the spring	The first whip was put into the eaves so that cattle do not stray from the pasture
Calendula officinalis L (Compositae)	Saialill	Diarrhoea in cows[a], inflammation[a]	Decoction given to drink

Carlina vulgaris L. s.l. (Compositae)	Keelikurohi	Ceases to ruminate	Decoction given to drink
Carum carvi L. (Apiaceae)	Köömned	Increase milk productivity	Decoction of seeds given to drink
Chelidonium majus L. (Papaveraceae)	Vereurmarohi	Babesiosis, tick diseases[a], milk fever[a], post-parturient hypocalcaemia[a], or parturient paresis[a]	Decoction, water or alcohol infusion is given to drink
Cirsium heterophyllum (L.) Hill (Compositae)	Keeliku rohi[a], haavaleht, kuue haava leht, valgepoolega leht	Babesiosis[a] Wounds, erysipelas	Aerial parts given to eat[a] Topical application of the leaf
Coffea spp. (Rubiaceae)	Must kohv, kohv	Urinary retention (ischuria) Postnatal period	Strong black coffee given to drink with a bottle Coffee with grounds are given to drink
Crataegus oxyacantha L. (Rosaceae)	Kontmaripuu	Arthritis, polyarthritis, foot disorders	Decoction of twigs given to drink
Cucumis sativus L. (Cucurbitaceae)	Kurk	Fodder[a]	In spring, lacto-fermented cucumbers were fed to animals
Cypripedium calceolus L. (Orchidaceae)	Külmkinga rohi	Eye diseases (runny eyes)	Water infusion of aerial parts and 9 burning coals, used to wash the cow's eyes
Dryopteris spp. (Dryopteridaceae)	Sõnajalg	Against all diseases	The roots of the fern picked on Midsummer's night to treat all diseases
Frangula alnus Mill. (Rhamnaceae)	Paaspuu, paakspuu	Fodder[a]	"Cows eat very well from this bush"
Fraxinus excelsior L. (Oleaceae)	Saar	Fodder[a]	Branches with leaves as winter food
Glechoma hederacea L. (Lamiaceae)	Maaaljarohi	Urticaria	Washing with decoction was followed by magical ritual involving a therapeutic stone

(continued)

Table 15.1 (continued)

Latin name (family)	Folk name	Purpose of use	Application
Hordeum vulgare L. (Poaceae)	Oder; linnased [malt]	Diarrhoea in cows	Roasted seeds were given to eat
		Verrucae	A number of grains equal to verrucae were rubbed on them and thrown into furnace
		Postnatal period	Roots remaining after cultivation of malt were given with a drink
		Retention of afterbirth	Germs and roots remaining after the cultivation of malt were given with a drink
Hypericum spp. (Hypericaceae)	Harilik naistepuna	Diarrhoea in calves[a], poisoning with plants[a]	Decoction given to drink
Inula helenium L. (Compositae)	Ollandilehed	Foot diseases	The leaves fed to animals
Juniperus communis L. (Cupressaceae)	Kadakas	For the health of calves[a], for health (vitamins)[a], arthritis, polyarthritis (prevention), diarrhoea in cows	Branches boiled and given to drink
		Witch eye[a]	The smoke from juniper was made[a]
		Fodder[a]	Boughs given to eat[a]
Levisticum officinale W.D.J.Koch (Apiaceae)	Liistok, liistük	Snake bite[a]	Juice applied on the wound, a leaf of the plant kept in fish brine put on the wound[a]
		Babesiosis	Decoction of greater plantain (*Plantago major*), lovage (*Levisticum officinale*) and radix of common sorrel (*Rumex* spp.) given to drink with flaxseed oil

Linum usitatissimum L. (Linaceae)	Lina	Diarrhoea in calves[a], healthy (vitamins)[a], ceased rumination[a]	Boiled seeds and given to drink[a]
		Ceased rumination	The tows boiled and given to drink
		Constipation	The seeds were boiled until they became flattened and were given to drink
		Tympany[a]	Flaxseed oil given to drink[a]
		Babesiosis	Oil was given with decoction made of greater plantain (*Plantago major*), lovage (*Levisticum officinale*) and radix of common sorrel (*Rumex* spp.) (*Levisticum officinale*) and radix of common sorrel (Rumex spp)
		Erysipelas	Topical application of flaxseed oil
		For wound closure	Linen cloth strips topically applied
		Babesiosis	The tows boiled for as long as the water lasts and then consumed
		Retention of afterbirth	The tows boiled and given to drink
		For the health of calves[a]	The seeds were put in calf food[a]
Matricaria chamomilla L. (Compositae)	Kummel	Postnatal period	Flowers put into drinking water
Matricaria discoidea DC. (Compositae)	Koerakusekummel	General sickness in animals[a]	Decoction given to drink
Nicotiana rustica L. (Solanaceae)	Tubakas	Cattle lice	Wash the animal with decoction, several times, if necessary
		Tympany	The stem of a long pipe full of tobacco was put into the cow's rectum and tobacco burned; when the tobacco has burned off, the animal was believed to be cured
Petroselinum crispum (Mill.) Fuss (Apiaceae)	Petersell	Urinary retention (ischuria)	Decoction of roots (and occasionally fish air bladder) was given to drink
Picea abies (L.) H.Karst. (Pinaceae)	Kuusk	Old wounds	Topical application of ointment made with resin, pork fat, wax and alum stone in spring; decoction of shoots given to drink
		Cough	
		Fodder in spring[a]	Twigs given to eat[a]

(continued)

Table 15.1 (continued)

Latin name (family)	Folk name	Purpose of use	Application
Pinus sylvestris L. (Pinaceae)	Mänd	Fodder in spring[a]	Twigs given to eat[a]
		Fresh wounds	The bottom white side of bark was placed on a wound
Plantago major L. (Plantaginaceae)	Teeleht	Babesiosis	Decoction made of leaves and lovage (*Levisticum officinale*) and common sorrel radix (*Rumex* spp) and given with flaxseed oil
		Old wounds	Leaf put on wounds
Potentilla erecta (L.) Raeusch (Rosaceae)	Tedremaran	Stomach-ache	Roots given to eat
Primula veris L. (Primulaceae)	Käekuatsa	Postnatal period	Decoction of flowers was given to drink ["which would give yellow milk"]
Prunus padus L. (Rosaceae)	Toomingas	Diarrhoea in calves[a]	Decoction of twigs was given to drink
		Ritual[a]	It was not allowed to use it for making cattle whip made; would make animals ill
Quercus robur L. (Fagaceae)	Tamm	Diarrhoea in calves and cows[a]	Decoction of bark or acorn and was given to drink[a]
		Diarrhoea in cows, postnatal period	Decoction of bark was given to drink
Rumex spp. (Polygonaceae)	Oblikas	Babesiosis	Decoction of roots with leaves of greater plantain (*Plantago major*), lovage (*Levisticum officinale*) and given with flaxseed oil
Salix repens L. (Salicaceae)	Kõuepaju	Spoiled milk (due to fright from thunder)	Branches boiled and given to drink
Sambucus nigra L. (Adoxaceae)	Leederpuu, leedripuu	Babesiosis; cough	Flowers given to eat; tea from the flowers given to drink
Secale cereale L (Poaceae)	Rukis	To strengthen health[a]	Grains stewed and given to eat[a]
		Retention of afterbirth	A hot flour soup was given with a meal
		Cattle lice	Ointment made with gunpowder, sulphur, quicksilver, fat, butter, twitch grass, beeswax and copper sulphate [copper vitriol]

Solanum tuberosum L. (Solanaceae)	Tuhlis	Burn wounds	Cut potato topically applied
		Urticaria	Potato cut, one half thrown into the forest, the other was rubbed on the animal three times and then placed under a stone
Sorbus aucuparia L. (Rosaceae)	Pihelgas, pihlakas, pihla	Cattle lice	9 lice placed under bark or 9 lice shot from a gun into a tree
		Wounds	Decoction of bark used to wash a wound, then greased with seal fat
		Old wounds	Topical application of bark infusion
		Ritual	The first whip was put into the eaves so that cattle do not stray from the pasture
		Ritual[a]	"Do not hit animals with a rowan branch, it becomes ill"[a]
Tanacetum vulgare L. (Compositae)	Soolikarohi	Diarrhoea in calves	Decoction given to drink
Taraxacum sect. *Taraxacum* F. H. Wigg. (Compositae)	Võilill	Ritual[a]	Wreaths plaited and put on the cow and shepherd on Midsummer's day
Thuja occidentalis L. (Cupressaceae)	Elupuu	Retention of afterbirth	Decoction given to drink
Thymus serpyllum L. (Lamiaceae)	Liivatee, liivarohi, liivanõmme tee, timmerjaan	To improve health[a]	Decoction given to drink[a]
		Urinary retention (ischuria)	Tea was allowed to pass through a natural hole (tree, stone, table) and given to drink
		Cough	Decoction given to drink
Tilia cordata Mill. (Malvaceae)	Lõhmuspuu	Burn wounds	Bark infusion applied on the wound
		Old wound	Wash with inner bark infusion
		Erysipelas	The bottom white side of bark was placed on the skin
Trifolium montanum L. (Leguminosae)	Jaanirohud	Postnatal period	Decoction given to drink
Trifolium sativum L. (Leguminosae)	Härjapea	Postnatal period	Decoction of flowers given to drink

(continued)

Table 15.1 (continued)

Latin name (family)	Folk name	Purpose of use	Application
Trifolium spp. (Leguminosae)	Ristik, ristikhein	Fodder[a]	Was sown in pasture
Tussilago farfara L. (Compositae)	Vaeselapseleht	Cough	Decoction of leaves given to drink
Urtica dioica L. (Urticaceae)	Nõges	Metritis[a] Fodder[a]	Decoction given to drink ("if animal does not drink, put flour in") Dried and given to eat in winter
Valeriana officinalis L. (Caprifoliaceae)	Vallerjaan	Stomach-ache	Decoction of roots given to drink
Verbascum thapsus L. (Scrophulariaceae)	Üheksajuur	Diarrhoea in cows	Roots boiled in beer and given with water
(?) *Lamium purpureum* L. (Lamiaceae)	Punaste lehtedega nõgesed	Babesiosis	Fed to cows

[a]Use recorded in 2014, but refer to the time when animals were still kept or even to the childhood of the respondent (for which limited details were given). If not marked, the record dates to 1928 (?) Identification based on plant description

Fig. 15.3 Traditional Saaremaa wood pasture near Kuressaare. (Photo Renata Sõukand, 2015)

15.3.2 Modern List of Herbs

The modern list of herbs seems short at first glance, but if we take into consideration that the same herbs have been used for similar illnesses in animals and humans (e.g. different wounds, coughs, skin ailments, etc.), the list is much longer. Therefore, although fewer herbs are used today for specifically treating animals, as animals are no longer raised, these treatments are still being used in humans. This is also reinforced by many popular medicine books published recently.

If we compare the two lists, it becomes apparent that many of the historical herbs are still being used today. For example, recent fieldwork recorded the use of the water from linden (*Tilia cordata*) bark and the juice of aloe (*Aloe arborescens*) leaves for burn wounds; the use of spruce (*Picea abies*) resin ointment and broadleaf plantain (*Plantago major*) for wounds; the use of tormentil (*Potentilla erecta*) roots for stomach ailments; and the use of coltsfoot (*Tussilago farfara*) leaves and Breckland thyme (*Thymus serpyllum*) herbal tea for coughs, all of which were classified as treatments for animals in the archival texts.

In the nineteenth century, the literature recommended giving animals caraway seeds (*Carum carvi*) for increasing milk production (Ollino 1897, third print was issued in 1909). Although this use has not been noted in folklore texts, during fieldwork it was still known that caraway seeds improve milk production, but it was specified that the respondent had read about this use and had never used the seeds in such a way. As a result this information is not shown in Table 15.1.

15.3.3 Recommendations in Literature as Influencers of Herb Use

Use of medicinal plants in ethnoveterinary medicine is generally considered to be "rational", and it is recommended in both veterinary books and popular books on medicinal plants. The first Estonian medicinal plant book *Ma-rahwa Koddo-Arst* (Jannau 1857) even included a number of recommendations for improving the well-being and treatment of cows. Published handbooks and the popular science literature gained a lot of momentum in the beginning of the twentieth century.

Here analysis can be carried out only with regard to those usages for which there is reference to the archive or notes from fieldwork. The total list of various herbs and their usages noted in the literature is not the subject matter of this article. However, one exception needs to be mentioned: juniper (*Juniperus communis*) berries, according to the AVA materials and recent interviews, have not been used to treat animals at all. Nevertheless, Saaremaa is the most juniper-rich Estonian county, and the ethnoveterinary literature highly recommends juniper berries for the treatment of lung diseases, peritonitis, agalactia, oedema and poor milk consistency (Tõnisson 1890, Ollino 1897, Wöhrmann 1930s). Likewise, people have not used berries to treat themselves; however, in recent years (Kalle and Sõukand 2016) it has become accepted that these berries are beneficial and therefore they are eaten for prevention, but not for treatment. They have been used only for urinary incontinence of a single child, but it was specified that this was recommended by the local healer. The literature (Tõnisson 1890) has also recommended boiling wooden milk containers in hot water with juniper branches to prevent an unpleasant taste in milk and to prevent milk from spoiling. In addition, recent fieldwork has demonstrated that hot juniper water is used for boiling wooden containers, but these barrels were no longer used for storing milk but rather for meat, fish, lacto-fermented cucumbers and sauerkraut.

Many earlier Estonian veterinary books noted that they were prepared on the basis of a translation of the work by V. Metterlingk (e.g. Wöhrmann 1930s, Vinkler 1938; Vaiksaar 1939 [third print was published in 1940]), who was a professor at the veterinary clinic of the University of Tartu and presumably a Baltic German who published in German. Often the translators did not note the Estonian names along with the Latin names of herbs, and this may have impeded understanding and thus the use of the herbs. For example, in the case of constipation, the literature recommended giving an animal a little bit of *Napellus* and *Cannabis* (Wöhrmann 1930s), for which there is no information that people actually used them.

15.3.4 Using Foreign Species to Treat Animals

The use of foreign species closely reflects the impact of the literature as this is the first source of knowledge on the medicinal properties of a certain species. Yet, people have sometimes changed these recommendations according to their knowledge.

For example, several veterinary brochures (Tõnisson 1890 [4 prints published, last in 1903] Wöhrmann 1930s) instruct that in the case of bovine flatulence, a solution of tobacco (*Nicotiana rustica*) and salt should be inserted anally into the animal. From the archival text, we learn that tobacco is put inside a long pipe, which is inserted into the rectum of the animal and then lit. When the pipe burns down, the animal is cured. However, another recommendation for using tobacco, namely, washing animals with tobacco water to treat bovine lice, has been adopted without changes.

Parsley (*Petroselinum crispum*) has been one of the most recommended herbs in the literature for the treatment of kidney and bladder issues in both people and animals. In earlier times, people also adapted the use of this herb with their own knowledge. For example, in Saaremaa, fish air bladders were added to a parsley decoction to treat ischuria. It is thought that this was done because like [bladder] could cure like [bladder diseases]. Although parsley has not been recorded as a treatment for cattle in Saaremaa, people still use it widely for their own urination problems.

One of the foreign species most widely promoted in the literature for the treatment of people and animals has been elder (*Sambucus nigra*). For example, it is recommended to give elder flowers to cows to alleviate coughing (Jannau 1857, Wöhrmann 1930s, and others). Yet its implementation is limited by the fact that the Estonian climate is not suitable for this bush, and it can be grown only in Western Estonia and Saaremaa, which have a milder climate. It very rarely grows in the wild, and thus this herb has not been adapted to the folk medicine of continental Estonia. According to the AVA, water boiled with elder flowers has been used in Saaremaa for bovine coughing and babesiosis. Today, people in Saaremaa eat the black elder berries to improve their overall health, but the plant is not used to treat animals.

The literature has also widely promoted the medicinal properties of chamomile (*Matricaria chamomilla*). The information provided in the AVA which states that cows are given water with chamomile flowers after giving birth derives from the literature where this decoction was recommended for reducing birthing pains (Tõnisson 1890). Another species of chamomile (*M. discoidea*) has become so wild in nature that people no longer consider it to be a foreign species, and it is deemed unsuitable for treating people.

With regard to modern cultivated species, one of the most popular medicinal herbs in Saaremaa is marigold (*Calendula officinalis*), which is used for dozens of different human ailments, as well as for treating animals, mainly infections. The increase in popularity of this herb in the last few decades has again been caused by popular medical books (e.g. Treben 1991, the fifth printing which was issued in 2017) and its forceful promotion by the former local pharmacist and in his published books (Mandre 1994, third printing published in 1999; Mandre 1999, third printing published in 2001).

In the early literature, if there was no Estonian name for foreign species, they were presented in German, as the books were mainly translated from the latter. For example, horse-heal (*Inula helenium*) is called *Alant* in the medical books. However, people adapted these foreign works to suit their needs. In Saaremaa it has been noted that in the case of cow foot illnesses, horse-heal leaves should be given to an animal, without specifying the application method. But if we also study the folklore collected from Western Estonia at the same time (Sõukand and Kalle 2008), it is revealed that these were boiled and given to the cow to drink in the case of bone illnesses. Today, horse-heal is practically unknown in Estonian folk medicine, as it is no longer grown as a medicinal herb and has escaped into nature from gardens.

15.3.5 Herbs Used for Ritual Purposes

In Saaremaa, two species of *Alnus*, either black alder (*A. glutinosa*) or grey alder (*A. incana*) which cannot be identified by the name in the archival texts, have been used for ritual purposes. Alder wood was considered special and magical because breaking or cutting a raw tree results in the wood turning red, thus creating the illusion that blood is seeping from the tree. This is the reason why when cows had babesiosis, an alder stick was stuck into the ground where it occurred the first time so that the alder would trap the illness inside the ground. In a similar manner, alder was used in the case of milk spoiling: spoilt milk was put inside a log and then thrown into a burning furnace – the wood would take away the bad, and it would be destroyed in the fire.

Rowan (*Sorbus aucuparia*) also used to be an important holy tree in folklore. Folklore texts say that the first springtime cattle whip had to be made of rowan, and at the end of the day, the whip was placed in the eaves – this way the cattle would not stray from the pasture. During the recent fieldwork, it was repeatedly said that an animal may not be struck with a rowan stick as then it would fall ill, the milk would go bad or the bulls would begin to hit that particular cow. Similar qualities were also attributed to hackberry (*Prunus padus*). It was believed that animal lice were due to "the evil eye", and rowan was used for exterminating them. Nine lice from the animal's back were put under tree bark or loaded into a gun and then shot towards a tree. Apparently, the tree was to take in the lice and save the animal from this pest.

Juniper (*Juniperus communis*) has also been a culturally important tree. Nowadays its medical properties are primarily known, but it is still also important as a magical tree. For example, the fieldwork recorded that juniper branches were used to smoke rooms during funerals, in case of infectious disease, and also to repel flies. On the one hand, it was explained that juniper smoke is used as a disinfectant, but on the other hand, it was said that the smoke cleans rooms of witchcraft. Smoking was also used to treat animals. When the animals had diarrhoea at the collective farm and all medical approaches had been unsuccessful, it was thought that the ailment was the result of witchcraft, which can be fought only by witchcraft. For this reason, the ritual of smoking with juniper branches was carried out at night, in secret, without telling anyone.

In earlier times, the roots of ferns (*Dryopteris* spp.) gathered on Midsummer's night were also considered to have magical medicinal properties. This belief arises from the fact that, although ferns reproduce by spores, the peoples of many Slavic nations, Finno-Ugric nations and Baltic nations believe that ferns bloom during that period. The person who finds the blossom will have good luck and health, and roots gathered during that time were believed to cure all diseases.

In Estonian folk mythology, lady's-slipper orchid (*Cypripedium calceolus*) was considered to be an important wonder cure endemically in Saaremaa. This plant is more common in nature in Saaremaa and Muhumaa than in continental Estonia. The earlier folk name of the plant, *külmkinga rohi* or cold-foot herb, in Saaremaa, means that this is an herb to ward off an evil spirit. All supernatural and sudden illnesses in both animals and people were thought to have come from either stepping on the footprints of a vengeful spirit or the "bad wind" created by the spirit. The only help against this deadly illness was considered to be the lady's-slipper orchid. In case of animals having runny eyes, it was thought to be caused by "bad wind". The herb was soaked in water, nine burning pieces of coal were added to the water, and then the water was used to wash the runny eyes of an animal.

15.3.6 Mosses, Algae, and Fungi for the Treatment of Animals

In this paper, uses of mosses, algae and fungi have also been analysed (Table 15.2). In Saaremaa, but not in continental Estonia, spore dust of the common puffball (*Lycoperdon perlatum*) was used for closing bleeding wounds, but this remedy is no longer used today. Also characteristic of the folk medicine of Saaremaa is the use of birch besom (*Taphrina betulina*) for treating both people and animals. This practice, although still used in Saaremaa today, is practically unknown as a medicine in continental Estonia. Birch besoms (Witch's broom) were mainly used to smoke children during contagious illnesses as it was thought that the branch tangles created by the fungus cure supernatural illnesses, which were thought to come from "bad wind", but this is no longer believed today. Earlier it was also thought that a "bad wind" sent by a witch causes eye ailments in animals and makes their eyes runny. For treatment, animals were massaged with the Witch's broom.

The historical popular medicine in Saaremaa differs from that of continental Estonia by the fact that bladderwrack (*Fucus vesiculosus*) is used for all kinds of skin diseases, especially those which are thought to have been caused by sea water. During the recent fieldwork, no one spoke of using bladderwrack for the treatment of animals, but people still treat their own painful joints with a bladderwrack infusion.

As it is possible to get a skin disease from the sea (called *merikid*), the treatment has to be obtained from the same place. Other algae have also been used for the same purpose, but their species or families could not be specified afterwards. The archival texts mention that "sea blossoms with a red cross" (probably a blooming and floating algae) have to be collected from the northern part of the sea and then put on infected skin.

One identification has been made only at phylum level, *Bryophyta*, as the folk name *katusesammal* cannot be assigned to a specific species or family. As the folk

Table 15.2 Mosses, algae, and fungi used for the treatment and wellbeing of animals in Saaremaa and Muhumaa

Latin name	Folk name	What it was used for	How it was used
Bryophyta	Katusesammal	Udder swelling	Warm moss put on the udder
Fucus vesiculosus L. (Fucaceae)	Karpmuda, Muda	Eczema madidans, eczema squamosum	Algae from stones were mixed with honey and then rubbed on infected skin. The algae were burned, and then the ashes were mixed with water and used for washing
Inonotus obliquus (Ach. ex Pers.) Pilát (1942) (Hymenochaetaceae)	Kasekäsn	General sickness[a]	Decoction given to drink
Lycoperdon perlatum Pers. (1796) (Agaricaceae)	Tuhkja	Bleeding from a wound	Spore dust topically applied
Saccharomyces cerevisiae Meyen ex E.C. Hansen 1883 (Saccharomycetaceae)	Pärm, õllepärm, koduõlle pärm, töömiis, leivapärm	Retention of afterbirth udder swelling	Given to drink with water or home-made beer
			Rubbed on the udder
			Given as fodder
		Constipation	About 1.2 l of beer yeast given to drink in a bottle; topical application of yeast or mixture of bread and yeast
		Tympany	
		Psoriasis, eczema	
Taphrina betulina Rostr. (Taphrinaceae)	Tuulepesa	Eye diseases	Witch's broom used for massaging

[a]Use recorded in 2014, but refer to the time when animals were still kept or even to the childhood of the respondent (for which limited details were given). If not marked, the record dates to 1928

name *katusesammal* or roof moss implies, it grows on the roofs of houses; and straw or thatched roofs used to be common in Saaremaa. It is specified that for the treatment of a swollen cow udder, moss has to be taken from the northern side of the roof. A suitable species could be whitish feather moss (*Brachythecium albicans* (Hedw.) Schimp.) or one belonging to the *Ceratodon* spp. family. Different species of moss have also been widely used as compresses for various illnesses, aches and swellings in humans. During the recent fieldwork, we also learned that heated moss has been used as a compress on aching joints (in human ethnomedicine).

Home-made beer was often recommended to treat various ailments by historical veterinary handbooks, and people have accepted these recommendations, for example, in the case of a retained placenta (Wöhrmann 1930s). However, people have also supplemented these recommendations, and have given, for example, liquid beer yeast (*Saccharomyces cerevisiae*), to animals in addition to the suggested beer. The AVA texts specify that beer and yeast cannot be given to a pregnant animal as this causes premature labour. The literature recommends giving half a mug of yeast to animals suffering from severe diarrhoea (Tõnisson 1890), but folklore texts recommend the opposite, that is, using yeast when an animal is constipated. The recent fieldwork revealed that the beer yeast was kept in a bottle or metal container in a cool place such as the cellar or well.

According to the fieldwork data, the chaga mushroom (*Inonotus obliquus*) has been widely used for the treatment of lung illnesses in people living in Saaremaa. It was also stated that the chaga mushroom was boiled and given to animals as well, but the intended use was no longer remembered.

15.4 Non-herbal Treatments

The most widely used mineral treatment used to be, in both people and animals, common salt. This was given to treat different diseases both separately and with various herbs. Salt was also known to have great medicinal properties, which are illustrated by a text written at the end of the nineteenth century: "The Saaremaa people never go out early in the morning without adding some salt to their boots, because they believe that salt protects against all witchcraft" (Sõukand and Kalle 2008).

Previously, when describing the customs of letting cattle out of the barn for the first time, it was revealed that common salt was thrown behind the animals when they went to the pasture and it was also given with bread to every animal so that it would protect them from disease. In addition, it was also mentioned that sprinkling salt into the tracks of the animals also was thought to keep the animals safe from wolf attacks during the summer. Giving salt was supposed to improve the animal's health, which is why it has also been given, dry or mixed into warm water, during the postnatal period. The practice of giving salt was also believed to help when the animal fell ill suddenly.

When being used as medicine, salt was put on wounds, or infected wounds were washed with salted water. Skin diseases were rubbed with salt, which was then put into three fireplaces on a Thursday evening. In the treatment of bone diseases, the animal's tail was cut and salt applied to the incision. If the animals had cataracts or other eye diseases, they were treated by putting salt in their ears with a feather or by blowing through a straw. Yet in case of human cataracts, it was more common to blow sugar, chalk dust and indigo dye into the eyes.

With regard to metals, iron and quicksilver were used for treatment or wellbeing. Iron tools were used in rituals when letting cattle out of the barn for the first time in spring (in front of the doorstep so that animals would step over it). At other times, an iron horseshoe was used as a talisman and put into the washing-up water of milk containers or the animals' drinking water. Quicksilver was recognized for its magical protective qualities, which is why it was tied in a small cloth bag around the necks of animals in a barn if it was thought that an evil spirit was haunting the animals. Quicksilver was also added to ointments to combat lice. Feeding quicksilver mixed into lard was supposed to help if the animal did not ruminate. In addition, quicksilver was recommended as medication for different illnesses by informants during recent fieldwork as well as by earlier veterinary handbooks (Ollino 1897, Wöhrmann 1930s).

In the case of broken bones, animals were given copper or silver dust (scratched from a silver coin). Silver coins and jewellery (rings, brooches) and copper coins were also put into colostrum when boiling it, and sometimes these items were taken to the church afterwards. These items were believed to help the cow produce a lot of milk in the future and for the milk not to spoil. Skin diseases were treated by rubbing the affected area with silver, copper or iron horseshoe nails.

With regard to minerals, blue clay was used to treat foot diseases in animals, but it was not specified how, apart from the animals standing in the clay. Blue clay was also rubbed on animals when they had lice. The method recommended in the literature is that in order to prevent bone diseases in animals, bones should be burned to ash and then fed to the animal (Ollino 1897). The ashes were either fed with flour or mixed with water and given in a bottle. The water mixed with wood ash was also given to animals in the case of retained placenta.

Different oils and liquids were also used for treatment. Wood oil, which was presumably made of pine resin, was rubbed on the udder if it was swollen after giving birth or on the injured leg of an animal. Likewise, petroleum was rubbed on different wounds and stiff legs of animals. Gasoline was given to animals in the case of constipation. In earlier times, pharmacies used to colour wood oil red and sell it as an expensive miracle drug which was to be rubbed on split teats (Rohtsepp 1884), but people in Saaremaa have used fat from the abdominal cavity of pigs to treat split teats. This fat was and continues to be one of the most popular medicines in folk medicine. It was used as a component in all kinds of home-made ointments and also rubbed on swellings from snake bites. Seal fat was also used – given to an animal in case of coughing or rubbed on different wounds. Butter and sour cream have also been used for rubbing on wounds, while fresh cream has been used to treat split teats or swollen udders.

15.5 Viability of Traditional Knowledge in Cattle Farming in Modern Estonia

Dairy cattle farming is one of the most advanced and most competitive livestock sectors in Estonia. Although the number of dairy animals has decreased in recent decades, milk yield per cow has continued to increase (Estonian Livestock Performance Recording 2018). At the same time, the structure of the herds has changed due to the construction of new livestock buildings (loose housed free stall barns) and the introduction of modern farm technologies. Nearly 3/4 of the cows are kept in a herd with 100 or more cows, which requires the introduction of control mechanisms to ensure that consumers expect safe food production and animal welfare and health. The number of organic dairy cows is also declining in recent years, after a ban on tie-stall housing regulation came into force. In 2012 there were 2937 organic dairy cows in Estonia (about 3% of total dairy cattle), but in 2015 there were only 1966 cows (Leming et al. 2016).

In 2014 the Minister of Agriculture passed the development plan of organic production, which states that "Organic farming is maintaining traditional agricultural methods in cooperation with the development of science" (EMA 2014: 2). Organic livestock farming has greatly increased in the recent years: only from 2006 to 2013, the number of beef animals increased 2.5 times. However, the number of organic dairy animals decreased significantly during that period. Organic dairy farms are significantly smaller than conventional farms, and only 3 of the former farms had more than 100 cows. Approximately 16% of agricultural land is cultivated as organic (Statistics Estonia www.stat.ee). In 2012, only 1.7% of milk in Estonia was produced organically (EMA 2014). According to Statistics Estonia, in ordinary cattle farming, the minimum optimal herd size for beef animals is 50 individuals, and in the case of dairy animals, it is 300 individuals (Valdvee and Klaus 2012), and thus organic farmers can keep their cattle herds small only due to additional funding (governmental subsidies). But even the smallest conventional cattle herds today are larger than the historic village herds, which included animals from many farms.

The period of time following the collapse of the collective farming system is characterized by a reduction in the number of cows and herds, leading to increases in herd sizes and changes in breeds' proportions in the cattle population. Estonian Holstein and Estonian Red breed are the main dairy breeds in Estonia. If the proportion of these breeds was about 1:1 in 1990, then by 2011, three fourth of dairy cows were Estonian Holstein. However, Estonian Red breed is more favoured in Western Estonia and islands. But the inevitability and desirability of these changes have been under continuous social dispute. On the other hand, in spite of a reduction at the beginning of the 1990s, since 1990 average milk production per cow has increased significantly. That brings the dairy farmers to the same challenges as other countries with intensive dairy farming (Jaakson 2012). Figures 15.4 and 15.5 show pictures of the modern cow breeds on pastures.

The general long-term negative trend in the number of cattle farmers has now become irreversible. For example, only from 2001 to 2010, the number of bovine farmers in Estonia decreased fourfold (Valdvee and Klaus 2012), and small farmers in particular were those who terminated production. The decrease of small cattle farms began in the 1990s, when the economy changed from a planned economy to a market economy. In Soviet times, the size of dairy cattle herds kept at home was limited by the fact that people raised cattle in addition to their main jobs, and there was a national norm on how many fields and pastures a private animal owner could use. Then, as a result of land reform, there was a momentary abundance of small farmers, who began raising dairy cows. However, the market economy did not favour small farmers as the new owners (following privatization) of dairy plants ceased purchasing milk from unprofitable small-scale dairy farms.

The irreversible decrease began in the 2000s (Olmaru 2014). Therefore, it can be said that nowadays small farmers and private animal owners (who raise animals apart from their main job) have given up raising dairy cows and have switched to

Fig. 15.4 Modern cow breeds (Estonian Holstein and Estonian Red cows) on seminatural meadow near Lümanda. (Photo Renata Sõukand, 2015)

Fig. 15.5 Modern cow breeds in traditional Saaremaa wood pasture near Pöide. (Photo Renata Sõukand, 2015)

beef farming animals or, more commonly, have rented out their lands. Consequently, traditional cattle raising has died out in Estonia today.

In addition to supporting organic animal farming, the state also sponsors, from its nature conservation resources, the farming of smaller cattle, which would not otherwise be economically sustainable. Natural conservation funds are primarily given to managers of protected areas, with traditional landscapes or seminatural communities. These are areas where moderate human activities have helped to develop diverse communities, and when human activities end, the landscapes are dominated by reeds, bushes and forests. These areas were kept open by mowing and herding, but began to disappear after switching from extensive to intensive agriculture, primarily with the establishment of the Soviet system, which forced small farmers to join into large collective farms. Still, the largest change in land use has been caused by the drastic decrease in the number of animals since the turn of the new millennium, and thus today there are thousands of times less of these seminatural communities than there were during their peak time in the 1920s to 1930s. However, governmental subsidies have aided the farming of nontraditional animals such as Scottish Highland cattle (Fig. 15.6). These animals can stay outside throughout the year and need less care than other beef cattle. Therefore, although these cattle are few and traditional methods could be used, considering the lack of historical experience in raising new breeds, all knowledge now comes from school education. In addition, the legislation and norms regarding animal farming and environmental protection do not favour flexibility, and cattle farmers have been left with very little discretion for the creation of local knowledge arising from personal experience.

Today silage is one of the cheapest feeds in the cattle diet and is fed year-round in Estonia. Silage comprises an average 50% of milk production costs but is more nutritious forage than hay. In Estonia, silage is produced mainly from grasses and legumes (over 90%) and less from maize cultivars (Kaldmäe et al. 2014). However, in organic farms and smaller dairy farms (in many cases family farms), cattle grazing is often preferred, and silage is fed during the winter period. A few farms are

Fig. 15.6 Traditional landscape (alvar) is now habituated by Scottish mountain cows, new to Estonia and bred for meat. Near Kuressaare (Abruka island). (Photo Renata Sõukand, 2015)

feeding dairy cows only with hay in order to get better raw milk for cheesemaking. Although, dairy farming based on feeding the total mixed ration is more and more dominating in dairy cattle farming. Implementing such a feeding system, where the forage and grains are mixed together before being delivered to the animal, was first introduced in the early 2000s in Põlula experimental farm (Kärt 2006).

Modern dairy farming has changed in recent years in Estonia due to the implementation of a variety of precision technology and knowledge-based decision-making (Viira et al. 2015). With the help of science, diagnostic tools and software systems have been introduced, which is a significant help for the stockmen. New technology allows cattle breeders to discover more quickly and prevent the occurrence of diseases, therefore improving the health and welfare status of cattle. The latter shows that Estonian cattle farms are relying on the decisions of research outcomes. The beginning of research on animal husbandry in Estonia dates back to the year 1921, when the Animal Breeding Experiment Station was established just outside of Tartu. A total of 170 long-term projects were conducted there during the next 18 years, carried out under the supervision of Professor Jaan Mägi. The first feeding trials were carried out already in 1914, but there are no reports available of those studies (Tölp 2012). Nowadays, cattle trials are conducted either in the Eerika experimental farm (owned by the Estonian University of Life Science) or on commercial dairy farms all over Estonia.

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Chapter 16
Belarusian Ethnoveterinary Medicine: Ritual Practices and Traditional Remedies

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Keywords Belarus · Ethnoveterinary · Folk beliefs · Healing charms · Ritual healing · Husbandry magic · Plant and non-plant remedies

16.1 Introduction

Issues of health, illness, medical and magical healing practices have been explored by the scholars of a number of disciplines during the last centuries. The main focus of their concern was in human health care. Historians, folklorists and ethnographers have paid little attention to Belarusian ethnoveterinary medicine. An analysis based on ethnographic and folklore study aims to fill in this gap to some extent, concentrating on practices and methods that have been used by Belarusian peasants to treat livestock and preserve their health along with folk concepts and beliefs, which lay beyond them.

Ethnoveterinary medicine is understood here as a specific sphere of culture that is based on the whole traditional world outlook and includes empiric knowledge, ritual practices, a branched complex of folk beliefs as well as animal husbandry magic. This part of cultural experience preceded the official veterinary medicine and co-exists with it. Historically wide use of ethnoveterinary practices and remedies in Belarus was due to the almost complete absence of medical veterinary assistance from the state and local authorities. By the end of 1910, Minsk province Zemstvo administration had at its disposal only 16 precinct veterinarians, two veterinarians for business trips and 36 paramedics, according to the report of the Minsk Provincial Zemstvo Board about the state of the veterinary affairs (Otchyot Minskoy gubernskoy zemskoy upravy po delam zemskogo khozyaystva za 1910). Veterinary stations have been organized by the authorities throughout the country starting from

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the beginning of the twentieth century only, and their number was not enough to serve efficiently (Sivurava 2009). In unsatisfactory veterinary service conditions, private ethnoveterinary practices were the source of accumulation and improvement of knowledge on animal treatment. In contemporary society, when the veterinary service has become accessible and mostly free of charge, ethnoveterinary practices exist in rural areas mostly as auxiliary measures.

Ethnoveterinary medicine is tightly connected with the other aspects of ethnic culture, but the most important among them are the specificity of animal husbandry systems, special mythological beliefs, and interference of neighbouring traditions. Thus, the breeding of cattle, pigs and poultry has been traditionally widespread throughout the country, but horse breeding has been more common to the Podzvinnie and Podnieproŭje regions (Northern and Eastern parts of Belarus), whereas sheep breeding had a less important role in traditional husbandry and has been most intensively developed in Western Belarus (Kasperovich 2009). Goat breeding wasn't widespread among Belarusian peasants and was perceived as a sign of "extreme poverty" of certain peasant households. There was also a popular folk belief that breeding of goats could be the factor that harms breeding of other animals (Nikiforovskiy 1897). Such specificity of Belarusian husbandry affects the availability and diversity of information associated with treating certain animal species and its dissemination in different regions of Belarus. Obviously, the more significant an animal was for peasant households, the more diverse the list of diseases and methods of treatment for that animal.

As for Belarusian folk beliefs that to varying degrees determine inclusion of a particular species of animal into ethnoveterinary practice, it could be mentioned that cats and dogs were believed to be able to treat themselves without the help of humans ("Dog knows better than human what plant it needs, and always find it <the plant> for itself" "Сабака лучшай за чалавека знае, якога яму трэба зельля, і заўсёды сам сабе найдзе" (Piatkievič 2004); "cat has something healing in its claws" "кот у когцях мае нешта жывучае" (Piatkievič 2004)).

A good example of neighbouring traditions influencing Belarusian ethnoveterinary medicine is demonstrated by the distribution of charms for treating pig diseases, which are concentrated in the territory of Western Belarus only, although pig breeding was traditionally widespread throughout the country. Based on the specific verbal formulae of "medical advice", these charms, apparently, came to Belarusian tradition from Poland (Shrubok 2016a).

16.2 Historiography

Belarusian ethnoveterinary medicine as an object of comprehensive study has attracted little attention of researchers until recently. At the same time scholarly research on ethnoveterinary knowledge and practices in Belarus has had an essentially different approach than in the West, where academic interest in traditional health care for animals emerged in the mid-1970s and by the end of the twentieth century had already become an established academic discipline named ethnoveterinary medicine (Alekseevsky 2010). Meanwhile Western scholars demonstrated a great interest in studying plant and non-plant remedies used to treat animals and further practical implementation of the obtained knowledge, promoting the idea of sustainable development and environmental protection (McCorkle 1986; Berkes 2000), researchers in East Europe countries in general and in Belarus in particular concentrate mostly on folk beliefs and magical rituals associated with livestock health care. According to Luczaj et al. (2013), Belarus still remains *terra incognita* from the modern ethnobotany study's point of view.

The interest in Belarusian folk veterinary practices has apparently been aroused by the work of folklore collectors and researchers since the nineteenth century (Tyszkiewicz (1847), Shpilevskiy (1856), Kirkor (1858), Krachkovskiy (1869), etc.). Describing the customs and the way of life of Belarusian peasants of the time, researchers, as a rule, paid attention to the names of the diseases, diagnosis, prevention and treatment methods, symptoms and restrictions associated with different diseases. From the end of the nineteenth to early twentieth century, notions about folk veterinary appeared in the publications of Yanchuk (1889), Jeleńska (1892), Bulgakovskiy (1890), Romanov (1891, 1912), Nikiforovskiy (1897), Federowski (1897), Shein (1902), Dobrovol'skiy (1891, 1914), Bahdanovič (1995), Wereńko (1896) and others. They introduced in scientific circulation new field data regarding various ethnoveterinary aspects: people involved in treatment, folk beliefs about the causes of the diseases, verbal and non-verbal magical healing, plant and non-plant remedies used to treat livestock.

Significant contribution to the systematization and theoretical understanding of traditional concepts of Belarusians about the nature of diseases and ways of its treatment was made by Polish (Moszyński (1967), Pietkiewicz (2004), etc.) and Russian (Zelenin (1933), Popov (1912), etc.) researchers. For example, K. Mozsyński in his book devoted to the spiritual culture of the Slavs, analyzing traditional therapy methods, admitted that a special place there was given to different kinds of suggestions that, according to the scientist, explains the reason for the use of bitter, sharp, and thorny objects. The researcher has also emphasized the importance of sympathetic medicines – healing based on the principle of *similia similibus curantur* (like is cured by like) and *contratia contrariis curantur* (the opposite is cured with the opposite) (Mozsyński 1967).

In the first half of twentieth-century, the number of folklore and ethnographic research on ethnoveterinary and, more broadly, traditional treatment practices gradually ceased, since the interest in such issues, apparently, was not supported officially in Soviet science. Later, only a few "critical analyses" of ethnographic data on methods of traditional treatment from the Soviet period were published (Mińko 1962, 1969). Recently, research interest in Belarusian folk culture studies has shifted towards the cognitive aspects of ethnoveterinary knowledge – semantics of folk nominations and cultural models of diseases and its treatment (Valodzina 2001, 2004, 2007, 2009a, b, 2017), Shrubok (2015a, b, 2016b, c, 2017). Some aspects regarding remedies used by Belarusian peasants to treat livestock are recorded in the works of Sivurava (2009) and Šumski (2011). Ethnoveterinary knowledge of peasants in the present Liubań region has been analyzed by Sõukand et al. (2017a, b). However, thus far no comprehensive and complex research on Belarusian ethnoveterinary medicine regarding both the use of traditional medicines and ritual practices of treatment, has been published.

16.3 General Concepts of Livestock Diseases and Treatment Methods

Folk concepts of animal diseases and treatment methods are similar to the concepts of human diseases (Alekseevsky 2010). According to traditional folk beliefs, diseases were perceived as something extraneous that penetrated into the familiar harmonic world of humans and their households and violated the order and balance. The list of animal diseases and their symptoms (that are mentioned in historical sources most often) includes infectious diseases (plague, erysipelas in pigs (*roža*)), parasitic diseases (lice in calves, helminth parasites in sheep (*matylicy*)), various kinds of superficial damage to the skin (ulcers, wounds, sores, scabs, abrasions, bites, scratches), diseases of internal organs and their symptoms (bloat in cattle (*uzduc'cie/viacha/pavuk*), rumination problems in cows (*žvaki nie žuje*), blood in urine in cows (*kryvaŭka*), pulmonary emphysema in horses (*dychaŭka/sap*), etc.), leg and hoof diseases, eye diseases (wall-eye in cattle and horses (*bialmo*) and others.

The Russian ethnolinguist Anatoliy Zhuravlev, analyzing folk names of livestock diseases used by Slavic people, considered that most of them could be divided into two groups: (1) descriptive nominations reflecting the symptom of the disease (for example, *kolka/kolka – "prickling disease",* intestinal colic in horses) or its location (for example, *zavušnica/zaŭšyca – "behind-the-years disease"*, inflammation of the glands in pigs); (2) nominations explaining the cause of the disease, either natural (for example, *zakucie* – "*horseshoe disease*", the wound resulting from non-accurate horseshoeing) or supernatural (for example, a wide range of lexemes used for the nomination of "*an evil eye*" that, according to folk beliefs, some person can "put" on the animal causing disease – *ŭrok/zglaz/padumy/pryzor/prygavory*) (Zhuravlyov 1995).

Some of the folk names of livestock diseases are very hard to match with the corresponding names in official veterinary medicine, or even compose a clear and consistent picture of its symptoms. Thus one of the most often mentioned livestock diseases in the nineteenth to beginning of the twentieth century was *čemir/čemier,* which was usually defined as a horse disease that could also affect cattle and rarely people (Valodzina 2017). Regarding characteristic symptoms of the disease, the informants generally mentioned pain in the stomach and spasms, but there were also quite different explanations of *čemir/čemier,* for example as a tumor or rash. There is a quite similar situation with the other well-known term in folk veterinary nomenclature disease of horses and cattle named *pieralohi.* The descriptions of the disease in the dialect dictionaries and ethnographic literature are not very informative and just point generally to stomach pain, cramps and convulsions. There is even less information about *patnicy*, the name of the disease that often appears in the folk veterinary charms together with *čemir/čemier* and *pieralohi,* which is most likely used to describe the excessive sweating occurring as a result of illness of the animal, and represents not the name of the disease but its symptom (Shrubok 2017). In this way, similarities of the diseases symptoms lead to the implication that peasants in many cases poorly distinguish between differences in some diseases and may not differentiate between them.

The identification of the etiology of the disease is often a decisive step in determining treatment strategies due to the mythological postulate of the identity of the essence of things to its genesis (Valodzina 2007). Though peasants sometimes noted rational causes for some illnesses (e.g. cold, bad nutrition or udder injury for mastitis), in many cases they attributed the illnesses to supernatural forces. One of the most typical causes of livestock diseases, especially those connected with reducing cow milk production, according to the folk beliefs, is "an evil eye" and other kind of negative magical effect on health of the animal.

An important role in the etiology of many livestock diseases concerns the idea of demonological and chthonic worlds in relation to the world of humans and their households. According to local beliefs, chthonic creatures usually appeared harmful to domesticated animals and were often endowed with characteristics of the demonological beings that could cause diseases in livestock (a witch can turn into a frog or snake and milk a cow in such appearance, a weasel can ride a horse at night causing the diseases, etc.) (Zhuravlyov 1995). Thus, one of the most typical explanations for mastitis in cows is malefic activity of animal and bird deemed chthonic (weasel and swallow (Gura 1997)); mytho-semantic of bloat in cows (*uzduc'cie/viacha/pavuk*) is associated with pathogenic potencies of chthonic world representatives (the spider or mouse), etc.

Significant folk beliefs regarding the health of the cattle, namely, belief that some humans can influence cattle health through magic, belief in interaction between people and more powerful creatures (spirits, mythological owners of loci), have a function that goes beyond proper therapy and maintenance of health. In the mythological world outlook system the way out of the crisis caused by the disease was seen in setting relations with the environment through the contact with the disease and sacred assistants. Traditional ritual systems of treatment and preventing diseases in livestock unite various verbal, actional elements as well as different kinds of apotropes.

Despite the semantic and formal diversity of folk veterinary rituals, they are based on particular models or patterns, distinguished by the presence of similar semantic features, the relative stability of the structure and the identity of the inner mold. A significant part of the empirical material falls within the classification of healing rituals suggested by T. Valodzina, who defined models and motifs of *identification of the disease in the body, removal of it from the body, departure of the disease* and its *destruction*. The model determines the requisite chronotope and, to a certain extent, the verbal accompaniment of the healing ritual (Valodzina 2009b). Thus the model with semantic of destruction dictates the use of objects with sharp, stabbing, burning characteristics (for example, to treat mastitis in cows the cow was milked through sharp metal attributes (knife, needles, etc.) (Nikiforovskiy 1897; Shein 1902)); within the model of departure of the disease particular attention is paid to the loci, wherefrom and where the disease is exiled (usually it is various types of boundaries, such as the manor fence, threshold, gate, walls of the barn (Nikiforovskiy 1897; Wereńko 1896; Polacki etnahrafičny zbornik 2006), and places with marked negative semantics ("In the case of an evil eye, put three coals and three needles and transfuse <the milk of ill cow through it – A.Sh.> three times, and pour it out in a dirty place" "Еслі зурочыца, кладеш тры вогалька і тры голкі і тры раза пропускаеш і вымываеш у гразное место" (Data base "Polesskiy arkhiv": recorded by A n.d.)).

However, the list of basic models of rituals used to maintain health and treat livestock will not be completed without *apotropaic* model and *producing* milk yield model, which play a vital role in the ritual system of healing the cattle because illness itself has been less important than the loss of milk for peasant farmers. The apotropes used in ethnoveterinary ritual practices could be listed practically endlessly, but the unifying characteristic there is in their apotropaic and/or productive semantics. Universal remedies used in Belarusian ethnoveterinary include bread, salt, water, often consecrated in the church, attributes made of iron (especially needles, horseshoe), clothes of the owners of the animal, etc. (for example Fig. 16.1).

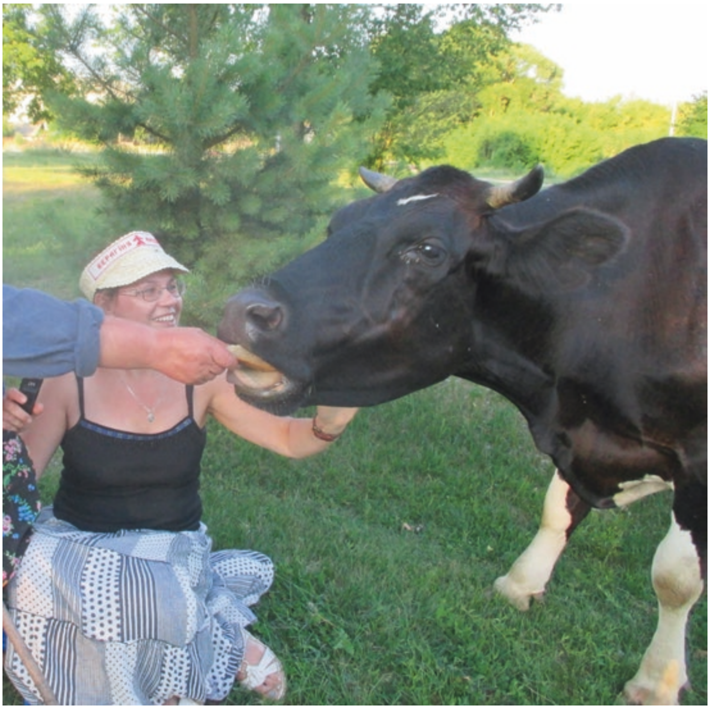

Fig. 16.1 Women feed bread to a cow to increase milk yield, spelling the charm. Slaŭharad district, Mahilioŭ region. (Photograph: T. Valodzina)

Fig. 16.2 Willow branches used for the first pasture rite (Liepieĺ district, Viciebsk region). (Photograph: S. Vyskvarka)

Healing rituals are often guided by natural phenomena (solar or lunar cycles) and socio-cultural events – especially the holidays. Orientation on certain holidays is more typical for preventative rituals, the purpose of which is to affect the animal's health in the future. The first pasture rite occupies a central place in the cycle of calendar preventive livestock rites. In the Belarusian folk calendar, the first pasture rite is timed to St. George's Day (sixth of May), as St George is thought to be the patron of livestock. On this day in different parts of Belarus, praying to St. George in churches, ritual rounds of flocks, and celebration dinners take place; the owners of the cattle strive to honor the shepherds, etc.

The most widespread ritual practices regarding preserving and improving livestock health performed on St. George's Day were beating the animal with a willow branch blessed in the church previously (Fig. 16.2), rolling an egg over the animal, transferring cattle through various kinds of apotropes laying under the threshold, etc. (Shrubok 2015c).

16.4 Charm-Healing and Belarusian Ethnoveterinary Charms

Treatment with verbal charms and incantations, embodied in the practice of ritual healing, was historically assumed to be an important way to eliminate the disease along with different types of remedies. Earlier folklore collector Cz. Pietkewicz remarked that “treatment with charms exists everywhere and belief in them was unusually high” (Piatkievič 2004). This type of treatment was provided by the healers, who were thought to possess magical power, although common peasants also had some proportion of charm-healing knowledge. Thus, a huge part of the charms used to treat cow diseases that were recorded by the folklorists recently seems to have been spoken by the people who didn’t consider themselves healers.

Belarusian ethnoveterinary charms constitute a branched corpus of texts aimed at getting rid of livestock diseases and maintaining their health. The corpus consists of charms treating cattle, horses and pig diseases along with the charms treating diseases common to animals and humans (rabies, wall-eye, a joint dislocation, “an evil eye”). Charms used for maintenance and reproduction of health of the cattle are the most numerous and developed complex in the whole system of Belarusian folk veterinary charms. Their specific feature is the general idea of increasing milk production in cows that can be traced in the various motif implementations in charms aimed to heal mastitis, “evil eye” and other diseases. In general, the boundaries between different functional groups of the charms healing livestock diseases are poorly reflected by the people who often use the same text or texts with similar motifs in different cases (Shrubok 2016c). A special place in the folk veterinary charms system belongs to verbal texts used for healing pigs, which are relatively rarely used in ethnoveterinary practice of Belarusians due to the ethnocultural reason – the widespread taboo against using charms for pig healing (Shrubok 2016a). At the same time there is a certain type of charms fixed in the territory of Western Belarus, which most likely came to Belarusian folklore tradition from the West through Poland, meanwhile in the East of Belarus the practice of fattening pigs using appropriate verbal charms is widespread.

The most diverse and numerous group in the whole Belarusian ethnoveterinary charms corpus is the charms used to heal cows, that can be explained not only by the very important role of cows in the traditional economy but also by their high symbolic status in the culture (Fig. 16.3).

Illnesses that reduce milk yield (most commonly mastitis) are treated with charms more often than any other cow diseases, because illness itself is less important than the loss of milk for peasant farmer. Many of these charms are preventative that are spoken before or at the time of a special occasion, i.e. first pasture rite or after calving and so on.

Belarusian charms for healing livestock mostly belong to East Slavic charms tradition, thus being spelling they are every time more or less accurately reconstructed by their plot, genre and thematic model with the help of different cliché belonging to the whole genre fund. Russian ethnolinguist and folklorist T. Agapkina defined and described two universal motif types of East Slavic healing charms (Agapkina 2010). First of them is “In the mythological center (in the open field, in the blue sea and on a white stone) there is somebody (the Virgin …), who treats X or in some other way helps to get rid of the disease”. In these type of charms, there are descriptions of the mythological center, where the main character of the charm destroys or expels the disease, protects the cured animal or illuminates the danger, returns or increases milk yield of the cow, etc. For example, “There is a stone on

Fig. 16.3 Gravestone with the image of the woman and the cow. Ryžoŭ village, Bychaŭ district, Mahilioŭ region. (Photograph: A. Liaškievič)

the sea, there is a church on the stone. There is a throne in the church, a girl seats on the throne. Black eyes, grey eyes, blue eyes, deep blue eyes. I have called three apostles, have expelled evil eyes from a cow and have poured it with milk (Repeat three times)" "На моры камень, на камні цэркаў стаіць. У той цэркве прастол стаіць, на прастоле дзевіца сядзіць. Вочы чорные, вочы серыя, вочы галубые, вочы сініе. Тры апосталы прызывала, з кароўкі ўрокі зганяла і малачком аблівала. (Паўтарыць 3 разы)" (Archive of Institution of Art History, Ethnography and Folklore of National Academy of Sciences of Belarus 1989).

The second universal motif type – is the illumination of the disease. The core of this type is the motifs that are based on the description of the disease (nomination of the disease, list of the sources and characteristics of the disease), as well as the expulsion of the disease (Agapkina 2010). For example, "Three girls walked, all of them were beauties. The first one was a laundress, the second – a seamstress, the third was embroidering the shirt of Lord God and chanting against the evil eye in my cow. <The girl> expelled <the evil eye> from her (cow's) legs, from her horns, from her udder to wilted withes, where the cock's voice does not reach, where sacred bread does not rise". "Шло тры дзевіцы і ўсе красавіца. Одна прачка, друга швачка, трэцяя Господу Богу сорочку вышывала, з моей короўкі ўрокі выговорала. З яе ног, з яе рог, з яе вымені, з яе раковіны на ніцые лозы ссылала, дзе пеўнеў голос не доходзіць, святы хлеб не родзіць" (Private archive of T. Valodzina n.d.).

The charms are often included in complex magical rituals and accompanied by the actions that strengthen the effect of healing. For example, "My cow Zorka has calved, strew herself with self-seed poppy, fenced herself off with the iron fence. As no one can collect this poppy, thus no one can take away milk from the cow. As no one can break the fence, thus no one can curse my cow. (Go around the cow three times, strew her and pronounce.)" "Мая карова Зорка ацялілася, самасеяным макам абсыпалася, жалезным тынам агарадзілася. Як гэтага маку нікому не падабраць, так у гатай каровы нікому малака не атбраць. Як гэтага тыну ніхто не пераломя, так маю карову ніхто не перагавора. (Тры раза абайці карову абсыпаць і сказаць)"(Tradycyjnaja mastackaja kuĺtura bielarusaŭ 2001).

16.5 Plant and Non-plant Remedies Used to Treat Livestock

Belarusian peasants did not use only the services of "magical professionals" to treat the livestock, but tried to treat it by themselves, using traditional preventive and curative remedies, important parts of which were made of plants. Plant remedies were brewed or used as a dry powder, which was added to the feed or was poured on wounds; dried plants were also used for fumigating the cattle.

The most commonly used wild plant taxa mentioned in historical literature and modern researches are *Acorus calamus* L. (аір, аер, плюшнік / *air, aer, pliušnik*)[1] for treatment of stomach disease in cows and redwater disease in cattle (Federowski 1897; Wereńko 1896); *Alisma plantago-aquatica* L. (шальнік /šaĺnik) to treat rabies (Romanov 1891; Dobrovoľskiy 1914); *Alnus* sp. (альха, вольха, алешына, альшына, алешнік /*aĺcha, voĺcha, aliešyna, aĺšyna, alieśnik*) to treat wounds and scrofula in cattle (Jeleńska 1892; Wereńko 1896), diarrhoea in cows and pigs (Nikiforovskiy 1897; Sõukand et al. 2017a); *Artemisia absinthium* L. (палын, палыннік /*palyn, palynnik*) to treat blood in urine and digestive problems in cows, helminthic disease in sheep, diarrhoea in chickens, cows and pigs as well as disinfectant for home animals (Piatkievič 2004; Wereńko 1896; Sõukand et al. 2017a); *Artemisia vulgaris* L. (былічка, чарнабыльнік, чорны палын, быльнік / *bylička, čarnaby'ĺnik, čorny palyn, byĺnik*) for blood in urine in cow treatment (Wereńko 1896; Sõukand et al. 2017a); *Ledum palustre* L. (багун, багон, багоўнік, буячнік/*bahyn, bahon, bahoŭnik, bujačnik*) to treat infectious diseases (Wereńko 1896), scabs and pulmonary emphysema in horses, rinderpest, diarrhoea in calves and cows (Piatkievič 2004; Wereńko 1896; Sõukand et al. 2017a); *Pinus sylvestris* L. (сасна, хвоя/*sasna, chvoja*) was indicated for treatment of a horse disease named *zubaйка* (Wereńko 1896), rinderpest and wounds in cows (Piatkievič 2004; Sõukand

[1] Here and below in branches there are local names of the taxa given in Cyrillic and Latin transcription.

Fig. 16.4 Harvesting of grass growing in the river Vilija for cows feeding in 1954. Byctryca village, Astraviec district, Hrodna region. Archive of Institution of Art History, Ethnography and Folklore of National Academy of Sciences of Belarus. (Photo library, photo №39a)

et al. 2017a). There are some data demonstrating that, for the purpose of increasing milk yield in cows, grass growing in rivers (*maŭra, raska*) was used (Fig. 16.4).

Such commonly known cultivated plants noted in nineteenth century literature as *Nicotiana sp.* (тытунь, табак/*tytuń, tabak*), which was marked as the remedy for helminthic disease in sheep (Federowski 1897), snakes bite (Wereńko 1896), scabs in horses (Piatkievič 2004), etc. or *Cannabis sativa L.* (каноплі, канапля/*kanopli, kanaplia*) used to treat helminthic disease in sheep (Piatkievič 2004; Federowski 1897; Wereńko 1896), scabs in dogs (Wereńko 1896) and some horse diseases (Romanov 1891; Wereńko 1896) were officially banned to be grown in home-gardens in different periods of the twentieth and twenty-first centuries (Sõukand et al. 2017b). The other cultivated plants used to treat home animals include *Linum usitatissimum L.* (лён/lion) used for the treatment of blood in urine in cattle (Piatkievič 2004), rumination problems and constipation in cows as well as diarrhea in cows and pigs (Sõukand et al. 2017b); *Calendula officinalis L.* (наготкі, календула/*nahotki, kaliendula*) as the prevention of miscarriage in cows (Piatkievič 2004); *Allium cepa L.* (цыбуля, лук/*luk, cybulia*) used for helminthic and infectious diseases in cattle (Tyszkiewicz 1847; Polacki etnahrafičny zbornik 2006); *Allium sativum* (часнок, чоснык/*časnyk, česnok*) to treat sore tongue (Jeleńska 1892; Federowski 1897; Wereńko 1896) and rumination problems in cows (Sõukand et al. 2017b); various vegetables (carrot and cabbage as the remedy for placental retention and rumination problems in cows (Federowski 1897; Sõukand et al. 2017b), radish and horseradish to treat urine retention (Piatkievič 2004; Wereńko 1896), cucumber for rumination problems in cows (Sõukand et al. 2017b)); etc.

Non-plant remedies have historically dominated over both wild and cultivated plant remedies in Belarusian ethnoveterinary. The great part of them was household products (brines (Piatkievič 2004), salt (Piatkievič 2004; Federowski 1897; Wereńko 1896), oil (Piatkievič 2004; Sõukand et al. 2017b), yeast (Romanov 1891; Sõukand et al. 2017b), kvass (Federowski 1897), soap (Sõukand et al. 2017b), lard (Jeleńska 1892; Federowski 1897; Wereńko 1896; Sõukand et al. 2017b), beeswax (Wereńko 1896), etc.). Thus abdominal distension (*tympania ruminis*) in cows that often occurred because of eating fresh clover, especially with dew on it or which was wet after rain, or due to bad quality of fodder was treated by buckthorn broth, hemp or linseed oil, as well as cucumber brine (Šumski 2007). Various milk products (cow milk (Piatkievič 2004; Federowski 1897; Wereńko 1896; Sõukand et al. 2017b), clabber (Romanov 1891; Wereńko 1896), sour cream (Jeleńska 1892; Wereńko 1896), liquid left after making curds (Romanov 1891; Wereńko 1896; Sõukand et al. 2017b), and milk cream (Wereńko 1896)) were used to treat ungulate skin diseases, urination and digestive problems in cattle.

Eggs were not only used in producing and healing rituals, for example, when the egg was rolled over the animal (often with spelling the incantation "let the animal be such round and sleek as the egg is") and then given to a beggar (Romanov 1912; Shein 1902), but was also indicated as a remedy for rumination problems and constipation in cows (Nikiforovskiy 1897; Federowski 1897), wounds and sores (Federowski 1897; Wereńko 1896), blood in urine in cows (Wereńko 1896) and diarrhoea in piglets (Sõukand et al. 2017b). Honey and birch tar application also played an important role in treating livestock diseases, being used to treat snakes bite (Wereńko 1896), sore tongue (Jeleńska 1892), scabs in pigs (Sõukand et al. 2017b), scrofula and malleus disease in horses (Nikiforovskiy 1897; Wereńko 1896), stomach ache in cows (Romanov 1912; Wereńko 1896), blood in urine in cows (Wereńko 1896), erysipelas suum and red fever in pigs (Shein 1902; Wereńko 1896; Sõukand et al. 2017b) as well as rinderpest (Romanov 1912; Federowski 1897). Being mentioned in historical literature as the remedy for constipation in cows and *vusač* in horses (Romanov 1891; Wereńko 1896), in modern Belarusian ethnoveterinary vodka/moonshine is used more broadly (Sõukand et al. 2017b).

Animal-based remedies are the most diverse and numerous group of non-plant remedies. The list of animals and parts of their bodies used in Belarusian ethnoveterinary includes bulls (Wereńko 1896), pigs (Federowski 1897; Wereńko 1896), deers (Federowski 1897), a variety of small mammals (moles (Federowski 1897; Wereńko 1896), polecats (Wereńko 1896), rabbits (Wereńko 1896), minks (Dobrovol'skiy 1914)), insects (honeybees (Federowski 1897; Wereńko 1896), *Geotrupes stercorarius* (Wereńko 1896)), birds (domesticated (Nikiforovskiy 1897; Wereńko 1896) and wild (Wereńko 1896)), amphibians (frogs, toads (Wereńko 1896)), reptiles (snakes (Federowski 1897)) (Fig. 16.5).

Although it is often not clear how exactly the animal or part of its body was used, the use of such kinds of remedies usually aims to "transfer" diseases from the domesticated animal to the other. The use of some substances obtained from human

Fig. 16.5 A body of a killed bird used as an apotrope to protect the cattle. Archive of institution of art history, ethnography and Folklore of National Academy of Sciences of Belarus. (Photo library)

and animal bodies (urine (Nikiforovskiy 1897; Romanov 1891; Federowski 1897; Sõukand et al. 2017b), feces or droppings (Nikiforovskiy 1897; Federowski 1897; Wereńko 1896; Sõukand et al. 2017b)) is often relied on a folk belief that diseases can be "expelled" from the body with help by any sort of uncleanness (Valodzina 2009b). However, the present study shows that among animal-based remedies, mainly practical and quite rational uses have continued to be used (Sõukand et al. 2017b).

16.6 Conclusions

Ethnoveterinary practices can be understood and interpreted appropriately only within their cultural context including the role of the animal within practical spheres of culture, primarily husbandry system, mythology and folk beliefs connected with issues of illness and health care. Traditional ritual practices of treatment and preventing diseases in livestock unite various verbal and actional elements as well as different kinds of apotropes. Despite their great variety, Belarusian ethnoveterinary practices are based on common folk beliefs concerning causes of livestock diseases and method of their treatment. Regarding a traditional worldview, disease was perceived as the disruption of established order and balance, the intervention of chaos into the regular world of peasants. Most often, ritual practices aimed to treat animal diseases follow certain models such as identification of the disease into the body, removal of it from the body, departure of the disease and its destruction, as well as apotropaic and producing milk yield models. Verbal charms and incantations used to treat livestock were often included in more complex rituals and played a major role in treatment of cow diseases, and diseases thought to be caused by supernatural causes (primarily "an evil eye").

Non-plant remedies are of great importance in Belarusian ethnoveterinary systems and include mostly various household products, although wild plants are almost equally important, while cultivated plants are less utilized. However, treatment of domestic animals with the help of both plant and non-plant remedies is less commonly described in ethnographic literature than magical methods used by Belarusian peasants.

The wide range of research questions such as the mechanisms of the evolution of Belarusian ethnoveterinary knowledge, regional provenance of different practices, interaction of book and traditional knowledge regarding treatment livestock, differences and similarities between ethnoveterinary knowledge and practices of various religious and ethnic groups living in Belarus, etc. still remains uninvestigated.

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Chapter 17
The Use of Plants for Animal Health Care in the Spanish Inventory of Traditional Knowledge

José Antonio González, Alonso Verde, and Manuel Pardo-de-Santayana

Keywords Ethnoveterinary · Veterinary herbal medicine · Animal feeding · Animal bedding · Traditional knowledge · Spain

17.1 Introduction

Ethnoveterinary medicine (EVM), the scientific term for traditional animal health care (McCorkle 1986; Martin et al. 2001; Mathias 2004; Wanzala et al. 2005), is a complex domain, as its synonym "veterinary anthropology" suggests (McCorkle 1986). It has a community-based approach to improve animal health and provides basic veterinary services in rural areas (Mathias 2007).

Phytotherapy and feeding are the most relevant domains of animal health care. There are also plants, such as those used as bedding that, although lacking direct veterinary use, are very relevant in animal health care. They favour animal well-being, isolating them from the damp and therefore protecting them against certain rheumatic or infectious diseases, colds, and painful hooves. Besides, many species that are collected for animal feeding have a direct effect on animal health as they contain pharmacologically active substances and can be considered nutraceuticals (see Pieroni et al. 2004).

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Ethnoveterinary medicine is a relevant aspect of traditional ecological knowledge. Many studies suggest that these knowledge systems contribute to the sustainable management of the environment (Pardo-de-Santayana and Macía 2015), and in fact the role of EVM in ecosystems health is becoming an important research topic. It is now becoming increasingly integrated into "participatory epidemiology", which seeks to improve epidemiological surveillance in remote areas and encourage community participation in disease control (Mathias 2004, 2007).

There is also an increase in the number of publications of EVM studies dealing with the search for new drugs developed after isolating natural extracts from EVM plants (e.g., Bahmani and Eftekhari 2013; Yigezu et al. 2014; Sharma and Manhas 2015; Uwagie-Ero et al. 2017; Assefa and Bahiru 2018), and new books discussing veterinary herbal medicine (e.g., Wynn and Fougère 2007; Katerere and Luseba 2010; Xie and Preast 2010) have appeared.

Thus, inventories or systematic studies addressing EVM should be promoted for three important reasons: (1) they can generate useful information needed to develop livestock healing practices and methods that are suited to the local environment; (2) EVM could be a key veterinary resource promoting the use of phytotherapeutics, including plants and plant-derived drugs, and (3) EVM can contribute to biodiversity conservation (e.g., Tabuti et al. 2003; Wanzala et al. 2005).

As Mathias (2007) said, it is necessary to expand our knowledge of all these aspects, above all in isolated geographic areas where self-subsistence economies are the norm and looking after the health of animals is crucial for the family economy. While this is essential in many areas of developing countries, it is also relevant in many other rural areas of the world, where owning a donkey or a mule, a pig and a few chickens is fairly common, desirable, and probably indispensable for the family economy.

There are still rural communities in Europe, especially in the Mediterranean region, where the health care of the members of a family extends to that of their domestic animals. The individuals in such communities attend to the needs of the livestock, used for fattening, for milking or for a supply of meat and eggs, and the plants that help to solve or alleviate the ailments of such animals. Although many of these plant uses have been largely forgotten in current society, the rural culture of the circum-Mediterranean area still conserves the use of many old herbal remedies for curing or treating animal health problems, at least in the memory of elders. The development of modern livestock-rearing techniques, administrative control and the rejection of popular remedies have promoted the abandonment of such practices (e.g., Davidović et al. 2011; Bartha et al. 2015; Piluzza et al. 2015; Ali-Shtayeh et al. 2016; Bullitta et al. 2018; Sinmez et al. 2018).

To halt this loss of traditional knowledge, many research projects have been conducted in Europe (see Viegi et al. 2003; Pieroni et al. 2006; Mayer et al. 2014), with Spain being one of the countries where more ethnobotanical studies have been conducted (Pardo-de-Santayana et al. 2014). Following the principles of the Convention on Biological Diversity (CBD), the Spanish law on Natural Heritage and Biodiversity has promoted the Spanish Inventory of Traditional Knowledge (henceforth "the IECT", for the Spanish name *Inventario Español de los Conocimientos*

Tradicionales). A large team of ethnobiologists, anthropologists and other scientists is developing this extremely important project for the recovery and safeguarding, at a national level, of traditional knowledge in general, and in particular of the ethnobotanical lore. At the moment five books have been published with information about 786 plant species, two mushrooms, one lichen, two animals, two minerals, and two ecosystems (Pardo-de-Santayana et al. 2014, 2018a, b, c; Tardío et al. 2018). The database reflects a great richness of traditional knowledge since more than 2700 vascular plants, 145 fungi, 108 animals have been traditionally used for multiple purposes, being "Human medicine" the use-category where a greater number of species are used. Other very rich categories are “Human food”, “Animal feeding”, “Social, symbolic and ritual uses”, “Industry and handicrafts”, and “Veterinary”.

Spain is one of the largest countries of Europe with an area of 505,992 km^2 and a population of more than 46,500,000. Until the 1950s, industrialization was concentrated in a few regions, and it was still an agrarian and rural country. Given its climatic, geographic and ecologic diversity, it has a very rich vascular flora composed of 7071 species. In addition to this high plant biodiversity, a complex history has brought a very rich cultural and linguistic diversity that has promoted a great ethnobiological diversity.

Since the end of the nineteenth century, this extensive traditional lore has attracted many researchers, but systematic ethnobotanical studies with reliable botanical identification did not appear until the 1980s. Since then, the number of studies has grown steadily.

Although in the last decade the number of references has increased (Bonet and Vallès 2007; Akerreta et al. 2010; Goicoetxea 2011; González et al. 2011a; Benítez et al. 2012; Carrió et al. 2012; López and Obón 2016), in Spain work addressing local EVM is rare. Undoubtedly, the published works are less numerous if we make a comparison with human ethnomedicine.

17.2 Materials and Methods

17.2.1 Data Collection

The IECT includes a database and monographs that register, organize and make accessible previously published traditional knowledge. The database compiles information from more than 200 publications that reflect the diversity of territories, biological groups and use categories of the Spanish ethnobiological knowledge (see Aceituno-Mata et al. 2014; Pardo-de-Santayana et al. 2018d). The monographs incorporate the information of the database and many other papers. For this chapter, we reviewed the five volumes of the IECT published (Pardo-de-Santayana et al. 2014, 2018a, b, c; Tardío et al. 2018) and the database for information related to animal health care.

17.2.2 Data Analysis

The realization of an inventory of these characteristics requires a classification of the traditional knowledge in order to organize the data in a systematic and coherent manner. A hierarchical classification was elaborated with 13 use-categories that are further divided in sub-categories. In this paper, we present an overview of the vascular plants used for animal health care: (1) veterinary herbal medicine, (2) animal feeding and (3) animal bedding. For veterinary herbal medicine, we checked the IECT categories “Veterinary” and “Toxic and harmful use” (only taking into account the sub-category “Poisons, insecticides and pesticides” that includes repellents against fleas and other external parasites). For animal feeding we checked the category “Animal food”. Finally, for animal bedding we checked the category “Environmental uses” (only considering the “Soil improvement” sub-category that includes plants used for animal bedding).

17.3 Results and Discussion

Considering the database generated in the development of the IECT, and taking into consideration the four use-categories considered in this book chapter, a total of 1608 vascular plant species have been traditionally used in Spain in the sphere of domestic animals or livestock health care. Besides, the veterinary use of non-vascular land plants as the liverwort *Marchantia paleacea* Bertol. (Bonet and Vallès 2007) and more than 50 wild animal species (González et al. 2016a, b) has also been documented.

17.4 Veterinary Herbal Medicine

17.4.1 Botanical Species

The veterinary use of 711 species of vascular plants belonging to 108 botanical families has been recorded. The four most relevant botanical families according to the number of species are Compositae (97 species), Lamiaceae (64), Fabaceae (48) and Poaceae (37). At species level, the taxa mentioned in the highest number of references are *Daphne gnidium* L. (48 ref.), *Olea europaea* L. (45), *Rosmarinus officinalis* L. (37), *Malva sylvestris* L. (36), *Allium sativum* L. (35) and *Sambucus nigra* L. (33). With the exception of *D. gnidium* the rest are important plants in human medicine and food.

17.4.2 Animal Diseases or Troubles Treated

The most frequent indications are skin animal diseases, in particular the treatment and cleaning of wounds, disorders of the digestive and genitourinary systems and parasite-induced ailments.

Several plant organs have been utilised for the preparation of veterinary herbal remedies. Aerial parts (flowered or not), branches/stems and bark are the most frequently employed plant parts. They can be administered fresh, directly after harvested, or dried.

17.4.3 Preparation and Administration Methods

The commonest method of preparation recorded is *cocimiento* (boiling in water), where the residual liquid is applied topically or given orally as a tisane. These *cocimientos* encompass decoctions and infusions. Such tisanes are used internally to treat digestive or other disorders, and externally to cure wounds or other illnesses. Another important way of applying the active principles of plants is in the form of poultices or ointments, where the plant is ground and applied directly as a paste to the affected area (wounds, contusions, etc.).

Regarding routes of administration, most of the herbal remedies recorded are for external use or are administered orally, and a limited number are applied through inhalation. The dose is usually dependent on the animal species and its age/weight.

Owing to their importance as working animals (used as beasts of burden), cattle and equines (especially donkeys and mules) suffered from many illnesses and were treated with a high number of species. Other animals commonly treated were sheep, goats and swine, which are extremely important in the practically self-sufficient economies of many families. A limited number of plants have been also used in the health care of rabbits, poultry, dogs or cats.

Table 17.1 lists the 13 most important veterinary plants (cited in more than 25 references) and includes botanical and ethnobotanical core information about these species.

To give an idea of the richness, diversity and characteristics of herbal veterinary remedies documented in the IECT, we present representative examples of relevant or interesting remedies used grouped according to the hierarchical classification of traditional knowledge established for this inventory.

Table 17.1 Most important vascular plant species documented for herbal veterinary medicine in Spain

Scientific name [vernacular names] (botanical family)	Use-category	Ailments (or animal conditions)	Part(s) used	Administration route	Animals treated
Daphne gnidium L. [*torvisco, matapollo*] (Thymelaeaceae)	Circulatory system	Haemorrhage	Bark	EXT	All livestock
	Digestive system	Diarrhoea	Bark	EXT	SHE, GOA, CAL
	Genitourinary system	To castrate male animals	Bark	EXT	SHE, GOA
	Conception, pregnancy and labour	Retained placenta, suppressor of heat, abortifacient	Whole plant, bark, branches, leaves	EXT, INT	SHE, GOA, CAL
	Respiratory system	Cold, pneumonia	Aerial parts, bark	EXT	SHE, GOA
	Musculoskeletal system	Bone fractures, dislocations, bruises	Bark, branches	EXT	All livestock
	Skin and subcutaneous tissue	Wounds, hoof cracks, pimples, warts	Whole plant, bark, leaves	EXT, INT	All livestock
	Sensory organs	Corneal leucoma, eye infections	Bark, aerial parts	EXT	SHE, DOG
	Other infectious and parasitic diseases	Glanders, anthrax, anti-helminth, distemper, myiasis, to remove ectoparasites (lice, fleas, mites)	Root, bark, branches, leaves	EXT, INT	All livestock
	Tumor diseases	Tumors (undefined neoplasms)	Branches	INT	POU
	Symptoms, signs and abnormal clinical and laboratory findings	Weakness (as a salutiferous)	Root	INT	POU, DOG
	Intoxication and poisoning	Contact with venomous animals (e.g., insect and spider stings, viper bites, scorpionism)	Branches, bark	EXT	All livestock
Olea eurpaea L. [*olivo*] (Oleaceae)	Digestive system	Diarrhoea, constipation, intestinal colic, intestine ulceration, liver affections, meteorism, mouth sores, abdominal pain	Fruits (olive oil), branches	EXT, INT	All livestock

	Genitourinary system	Mastitis and other udder diseases, urine infections, bladder inflammation, urethra obstruction	Fruits (olive oil)	EXT, INT	EQU, SHE, CAL
	Conception, pregnancy and labour	Retained placenta	Leaves, fruits (olive oil)	EXT, INT	PIG, SHE, GOA, CAL
	Musculoskeletal system	Bruises and contusions, rheumatism	Fruits (olive oil), leaves	EXT	All livestock
	Skin and subcutaneous tissue	Dermatitis, wounds, hoof cracks	Fruits (olive oil)	EXT	All livestock
	Other infectious and parasitic diseases	Anti-helminth, anthrax, scabies, myiasis, to remove parasites, tinea	Fruits (olive oil)	INT	All livestock
	Tumor diseases	Tumors (undefined neoplasms)	Fruits (olive oil)	INT	POU
	Symptoms, signs and abnormal clinical and laboratory findings	Undefined pain, weakness (as a salutiferous)	Fruits (olive oil)	INT	All livestock
	Intoxication and poisoning	Contact with venomous animals, by ingestion of toxic substances	Fruits (olive oil)	INT	All livestock
Rosmarinus officinalis L. [*romero*] (Lamiaceae)	Digestive system	Diarrhoea, indigestion, intestinal colic, meteorism, abdominal pain, liver afections, as a purgative	Flowered aerial parts, branches	EXT, INT	EQU, PIG, SHE, CAL, POU
	Genitourinary system	Urinary retention, mastitis and other udder diseases	Flowered aerial parts, branches	EXT, INT	EQU, CAL
	Conception, pregnancy and labour	To facilitate labour, retained placenta, aphrodisiac	Flowered aerial parts	EXT, INT	All livestock
	Respiratory system	Pneumonia	Flowered aerial parts	EXT	CAL
	Musculoskeletal system	Bruises and contusions, bone fractures, dislocations	Flowered aerial parts	EXT	EQU, SHE, DOG
	Skin and subcutaneous tissue	Wounds, dandruff	Whole plant, branches, flowered aerial parts	EXT	All livestock

Table 17.1 (continued)

Scientific name [vernacular names] (botanical family)	Use-category	Ailments (or animal conditions)	Part(s) used	Administration route	Animals treated
	Other infectious and parasitic diseases	Glanders, mumps, mange, to remove parasites	Branches, flowered aerial parts	EXT	EQU, SHE, DOG
	Tumor diseases	Tumors (undefined neoplasms)	Branches	INT	EQU, CAL
	Symptoms, signs and abnormal clinical and laboratory findings	Fever, weakness (as a salutiferous)	Branches	EXT, INT	EQU, PIG, GOA, CAL
	Intoxication and poisoning	Contact with venomous animals (e.g., insect stings and viper bites)	Branches	EXT	EQU, SHE, GOA, CAL
Malva sylvestris L. [*malva*] (Malvaceae)	Digestive system	Diarrhoea, constipation, colic, meteorism, gastrointestinal spasms, abdominal pain, as a purgative	Flowered aerial parts, leaves, flowers	EXT, INT	All livestock
	Conception, pregnancy and labour	To facilitate labour, retained placenta	Whole plant, flowered aerials parts	EXT, INT	PIG, SHE, CAL
	Respiratory system	Cold, pneumonia	Aerial parts	EXT, INT	All livestock
	Musculoskeletal system	Bruises and contusions, lameness, sprain	Flowered aerial parts, leaves	EXT	All livestock
	Skin and subcutaneous tissue	Furuncles, wounds	Flowered aerial parts, leaves	EXT	All livestock
	Nervous system	Overexcited animals (as a tranquilizer)	Flowered aerial parts	INT	All livestock
	Tumor diseases	Tumors (undefined neoplasms)	Flowered aerial parts	EXT	All livestock
Allium sativum L. [*ajo*] (Amaryllidaceae)	Digestive system	Diarrhoea, colic, indigestion, swelling, mouth sores, stomach inflammation, abdominal pain	Bulb, stem, flowered aerial parts	EXT, INT	All livestock
	Genitourinary system	Mastitis and other udder diseases, urine infections, bladder inflamention, urethra obstruction	Bulb, stem	EXT, INT	EQU, CAL, GOA, SHE

	Conception, pregnancy and labour	Stimulant of ovulation, aphrodisiac	Bulb	INT	POU
	Endocrine, nutritional and metabolic diseases	Gout	Bulb	EXT	All livestock
	Certain disorders involving the immune mechanism	Lymphadenitis	Bulb	EXT	GOA, SHE
	Skin and subcutaneous tissue	Wounds	Bulb	EXT	GOA, SHE
	Other infectious and parasitic diseases	Anti-helminth, distemper, glanders, to remove parasites	Bulb, stem, leaves	EXT, INT	EQU, POU, DOG, CAT
	Tumor diseases	Tumors (undefined neoplasms)	Bulb	INT	POU
	Symptoms, signs and abnormal clinical and laboratory findings	Loss of appetite, weakness (as a salutiferous)	Bulb, stem	INT	All livestock (mainly equines)
	Intoxication and poisoning	Contact with venomous animals (e.g., insect and spider stings, viper bites, scorpionism)	Bulb	EXT	All livestock
Sambucus nigra L. [*saúco*] (Adosaceae)	Circulatory system	Stroke (apoplexy)	Essence	INT	All livestock
	Digestive system	Meteorism, constipation	Inflorescence, flowers	EXT, INT	SHE, GOA, CAL
	Genitourinary system	Mastitis and other udder diseases, galactofugue	Bark, flowers, fruits	EXT	SHE, GOA
	Conception, pregnancy and labour	To facilitate labour	Fruits	INT	CAL
	Respiratory system	Cold, bronchitis, pneumonia, pleural infection	Flowers, leaves	EXT, INT	All livestock
	Musculoskeletal system	Bruises and contusions, joint pain, horn injuries	Flowers, leaves	EXT	EQU, SHE, GOA, CAL
	Skin and subcutaneous tissue	Wounds, chafing, hoof cracks and injuries	Whole plant, flowers, leaves, fruits	EXT	All livestock
	Sensory organs	Eye infections and irritations	Flowers	EXT	CAL

(continued)

Table 17.1 (continued)

Scientific name [vernacular names] (botanical family)	Use-category	Ailments (or animal conditions)	Part(s) used	Administration route	Animals treated
	Other infectious and parasitic diseases	Anthrax, mumps, distemper, mange	Flowers, branches, leaves	EXT	EQU, CAL, DOG
	Symptoms, signs and abnormal clinical and laboratory findings	Weakness (as a salutiferous)	Flowers, fruits	INT	All livestock
	Intoxication and poisoning	Contact with venomous animals (venomous stings and bites)	Flowers	EXT	All livestock
Quercus ilex L. [*encina, carrasca*] (Fagaceae)	Digestive system	Diarrhoea, indigestion, strengthening of jawbone	Bark	INT	EQU, CAL
	Conception, pregnancy and labour	Retained placenta	Bark	INT	SHE, GOA
	Respiratory system	Pneumonia	Bark	EXT	EQU
	Skin and subcutaneous tissue	Wounds, chafing	Bark	EXT	EQU, CAL
	Other infectious and parasitic diseases	To prevent cutaneous myiasis, mange	Bark, leaves	EXT	All livestock
	Symptoms, signs and abnormal clinical and laboratory findings	Weakness (as a salutiferous)	Fruits	INT	PIG, SHE
	Intoxication and poisoning	By ingestion of toxic substances (as a purgative)	Ash	INT	DOG
Marrubium vulgare L. [*marrubio, malrubio*] (Lamiaceae)	Digestive system	Indigestion, constipation, meteorism, as a purgative	Flowered aerial parts	INT	EQU, SHE, GOA, CAL
	Genitourinary system	Vaginal infections	Aerial parts	EXT	CAL
	Conception, pregnancy and labour	To facilitate labour, retained placenta	Flowered aerial parts	EXT, INT	CAL

	Respiratory system	Cold	Branches	INT	All livestock
	Musculoskeletal system	Bruises and contusions, lameness	Aerial parts	EXT	All livestock
	Skin and subcutaneous tissue	Wounds, baldness	Flowered aerial parts	EXT	All livestock
	Sensory organs	Corneal leucoma	Branches	EXT	GOA, CAL
	Other infectious and parasitic diseases	Swine erysipelas, cutaneous myiasis, to remove parasites	Aerial parts	EXT	CAL, PIG, POU
Eryngium campestre L. [*cardo corredor, cardo setero*] (Apiaceae)	Digestive system	Intestinal antiseptic and anti-inflamatory, stones in the liver	Stem, root	INT	EQU, RAB
	Genitourinary system	To castrate animals, mastitis and other udder diseases, urinary infections, urethra obstruction	Whole plant, stem, leaves	EXT	PIG, SHE, CAL
	Conception, pregnancy and labour	To facilitate labour	Root	EXT	SHE
	Respiratory system	Tuberculosis	Root	INT	CAL
	Musculoskeletal system	Bone fractures, dislocations	Root, stem	EXT	SHE, GOA, CAL
	Skin and subcutaneous tissue	Wounds, hoof cracks	Whole plant, inflorescence, stem	EXT	All livestock
	Other infectious and parasitic diseases	Myiasis	Stem and leaves	EXT	EQU, CAL
	Tumor diseases	Tumors (undefined neoplasms)	Stem	INT	POU
	Intoxication and poisoning	Contact with venomous animals (venomous stings and bites)	Whole plant, leaves, root	EXT	All livestock
Juniperus oxycedrus L. [*enebro, enebro de la miera*] (Cupressaceae)	Digestive system	Indigestion, constipation, liver infections	Cade oil, seed cones	INT	All livestock
	Conception, pregnancy and labour	Retained placenta	Cade oil, seed cones	INT	SHE, GOA
	Respiratory system	Cold, pneumonia	Cade oil	INT	All livestock
	Endocrine, nutritional and metabolic diseases	Gout	Cade oil	INT	All livestock

(continued)

Table 17.1 (continued)

Scientific name [vernacular names] (botanical family)	Use-category	Ailments (or animal conditions)	Part(s) used	Administration route	Animals treated
	Musculoskeletal system	Bone fractures, dislocations	Bark, cade oil	EXT	All livestock
	Skin and subcutaneous tissue	Dermatitis, wounds, hoof cracks	Seed cones, cade oil	EXT	All livestock
	Sensory organs	Corneal leucoma	Stem	EXT	SHE, GOA
	Other infectious and parasitic diseases	Brucellosis, swine erysipelas, mycosis, scabies, to remove parasites	Seed cones, cade oil, branches, leaves	EXT, INT	All livestock
	Tumor diseases	Tumors (undefined neoplasms)	Cade oil	EXT	All livestock
	Intoxication and poisoning	Contact with venomous animals (venomous stings and bites)	Cade oil	EXT	All livestock
Hypericum perforatum L. [*hipérico, pericón*] (Hypericaceae)	Circulatory system	Stroke (apoplexy)	Aerial part	INT	SHE
	Digestive system	Diarrhoea, indigestion, swelling, mouth sores	Flowered aerial parts	EXT, INT	EQU, CAL
	Genitourinary system	Diuretic, mastitis and other udder diseases	Flowered aerial parts	EXT, INT	All livestock
	Conception, pregnancy and labour	Anti-abortion	Aerial parts	INT	CAL
	Musculoskeletal system	Bruises and contusions	Flowered aerial parts	EXT	All livestock
	Skin and subcutaneous tissue	Wounds, chafing	Flowers, flowered aerial parts	EXT	All livestock
	Sensory organs	Ocular antiseptic and for ecchymoses	Aerial parts	EXT	All livestock
	Other infectious and parasitic diseases	Parasitic worms (helminths), ectoparasites	Flowererd aerial parts	EXT, INT	EQU
	Symptoms, signs and abnormal clinical and laboratory findings	Loss of appetite (as a tonic)	Aerial part	INT	All livestock

Juglans regia L. [*nogal*] (Juglandaceae)	Digestive system	Diarrhoea, colic, indigestion, constipation, meteorism, abdominal pain	Leaves	EXT, INT	All livestock
	Conception, pregnancy and labour	To facilitate labour, retained placenta, stimulant of ovulation, aprodisiac	Leaves, bark	EXT, INT	All livestock
	Respiratory system	Cold	Fruits, leaves	EXT	All livestock
	Musculoskeletal system	Bruises and contusions	Leaves	EXT	All livestock
	Skin and subcutaneous tissue	Dermatitis, infected wounds	Fruits, leaves, bark	EXT	All livestock (mainly cattle)
	Other infectious and parasitic diseases	To remove ectoparasites	Leaves	EXT	All livestock
Ruta chalepensis L. [*ruda*] (Rutaceae)	Digestive system	Diarrhoea, constipation, intestinal colic, meteorism, abdominal pain	Aerial parts, flowers	EXT, INT	All livestock
	Genitourinary system	Urinary retention, mastitis, vaginal prolapse	Aerial parts	EXT	CAL
	Conception, pregnancy and labour	Stimulant of ovulation, abortifacient, retained placenta	Aerial parts	INT	All livestock
	Respiratory system	Cold, pneumonia	Aerial parts	EXT	EQU, POU
	Musculoskeletal system	Inflammations, bruises, rheumatism	Aerial parts	EXT	CAL, GOA, SHE
	Skin and subcutaneous tissue	Warts, wounds, hoof cracks	Flowered aerial parts	EXT	All livestock (mainly cattle)
	Nervous system	Overexcited animals (as a tranquilizer)	Aerial parts	EXT	CAL
	Sensory organs	Eye infections	Aerial parts	EXT	GOA
	Other infectious and parasitic diseases	Swine erysipelas, ectoparasites (fleas), mange	Whole plant (flowered), aerial parts	EXT, INT	PIG, CAL, POU
	Symptoms, signs and abnormal clinical and laboratory findings	Weakness (as a salutiferous)	Aerial parts	INT	CAL, POU

Administration route: *EXT* external use, *INT* internal use. Animals treated: *EQU* equines (donkeys, mules and horses), *PIG* pigs, *SHE* sheep (ewes, rams and lambs), *GOA* goats (and kids), *CAL* cattle (cows, calves and oxen), *RAB* rabbits, *POU* poultry (hens and chickens, and turkeys), *DOG* dogs, *CAT* cats

17.4.4 Circulatory System

Many herbal remedies to stimulate the blood circulation in domestic animals have been documented. The aerial parts of the common nettle (*Urtica dioica* L.) have been used as a blood tonic. In Cantabria people gave the cows bottles of "nettle water" (Pardo-de-Santayana 2004, 2008). In Pallars (Lérida) pigs were fed with nettles cooked together with potatoes or a piece of the root of the nettle was put inside their mouths (Agelet 1999). In Huesca *Aristolochia pistolochia* L. was used as a blood tonic for cattle, mules and sheep, especially in the spring. The whole plant is crushed and burned, mixed with salt, adding the resulting ashes to the water drunk by the animals (Villar et al. 1987).

17.4.5 Digestive System

Certain diseases of the oral cavity, intestine and the digestive organs (stomach, liver or gallbladder) have been treated with plants, with remedies affecting digestive activity – i.e., those that favour digestion – the most important. For example, plants used to cure ruminants affected by meteorism or to treat equine colic.

Regarding remedies with digestive activity against meteorism, also known as tympanites, to expel air or gas accumulated in the abdomen or intestines of cattle, some people still use the liquid resulting from the decoction of *Malva sylvestris* leaves in Salamanca (González et al. 2011a), of *Valeriana officinalis* L. root in Lugo (Anllo 2011), and of *Herniaria scabrida* Boiss. mixed with pennyroyal (*Mentha pulegium* L.) in the Sierra Norte de Madrid (Aceituno-Mata 2010).

With the hairy leaves of *Verbascum pulverulentum* Vill., applied in the form of poultice together with pork lard, in Salamanca they cured indigestion in cattle (Velasco et al. 2010). In Pallars, the water of cooking *Chelidonium majus* L. was given to drink to sheep and hens when they showed signs of indigestion (Agelet 1999).

To treat equine colic, a very interesting curative practice, consisting in passing through the belly of the animal an odd number of times and tracing crosses with a stick, has traditionally been completed (Fig. 17.1). For this healing ritual, known as *magnar*, *maznar* or *varear*, sticks of *Corylus avellana* L. (Villar et al. 1987; Verde et al. 2008), of *Viburnum lantana* L. (Verde 2002; Fajardo et al. 2007), and mainly of *Ilex aquifolium* L. or *Nerium oleander* L. (e.g., Ferrández and Sanz 1993; Guzmán 1997; Verde et al. 1998; Agelet 1999; Fernández Ocaña 2000; Blanco and Díez 2005; Criado et al. 2008; Latorre 2008; Aceituno-Mata 2010; Velasco et al. 2010; Pascual Gil 2013), have been used.

Another very common illness treated with plants is diarrhoea. Many remedies have been documented as astringents. It is the most widespread use of *Daphne gnidium* L., by a "magical" practice that consists in tying their leaf-free branches or bark strips to different parts of the animal such as the neck (e.g., Blanco and Cuadrado 2000; Ortuño 2003; Benítez et al. 2012), the legs (e.g., Molina 2001; Gallego and Gallego 2008; Benítez 2009) or, more often, the base of the tail

Fig. 17.1 "*Magnando* a mare": passing a stick of oleander through the belly of the animal to cure equine colic. (Photograph: A. Verde)

Fig. 17.2 Bark strips of *Daphne gnidium* L. constitute a very popular remedy to cure diarrhoea in lambs. (Photographs: A. Verde)

(e.g., Penco 2005; Criado et al. 2008; Verde et al. 2008; Velasco et al. 2010; González et al. 2011a) (Fig. 17.2). In all cases, this is based on the belief that as the plant dries within a few days, the disease is cured. In some places, they indicate that this kind of "collar" has to be put on the animal before the sunrise (see Fernández Ocaña 2000).

In contrast, in Valencia a braid with three strips of the bark of *Clematis flammula* L. was tied to the goats and sheeps with diarrhoea (Pellicer 2000). Likewise, different tisanes have been prepared with plant species that have a high content of tannins. We can highlight the use of the flowered aerial parts of *Lythrum salicaria* L. (e.g., Bonet 2001; Pardo-de-Santayana 2004; Parada 2008; Akerreta et al. 2010), of the leaves and flowers of *Agrimonia eupatoria* L. (Bonet and Vallès 2007; Parada 2008), of the root of *Veratrum album* L. (García Jiménez 2007), of the flowers of *Verbascum sinuatum* L. (Parada 2008; Carrió et al. 2012), or of *Glechoma hederacea* L. together with rye bread (Latorre 2008).

Against constipation in sheep, in the Sierra Norte de Madrid, a branch of *Marrubium vulgare* L. wet in oil and introduced by the anus was used (Aceituno-Mata 2010).

In Pallars, the leaves of *Hepatica nobilis* Schreb. have been used to treat liver inflammation in hens, in the form of tisane or macerated (Agelet 1999). To treat gallbladder inflammation in sheep, in the Arribes del Duero (Salamanca-Zamora provinces) decoctions of *Digitalis thapsi* L. (whole plant) were given (González et al. 2011a). Branches and dry leaves of *Betula pendula* Roth ("due to their bitter taste") were given to goats in Pallars as an anti-cholagogue in cases of excessive production of bile (Agelet 1999).

In cases of oral infection, in Terra Chá (Lugo), they applied the leaf of *Verbascum thapsus* L. on the damaged tooth piece, cooked in milk together with an egg (Anllo 2011). Formerly, in Granada oral infections of donkeys were treated by cleaning their teeth with the basal part of a bunch of reeds (*Scirpoides holoschoenus* (L.) Soják) (Benítez 2009).

17.4.6 Genitourinary System

In this sub-section, we collect the use of plants gathered to treat different diseases of the urinary system (urinary retention, haematuria, cystitis, urethra obstruction), disorders of udders (mainly mastitis ant other inflammatory disorders) and female genital tract (uterine prolapse). Likewise, those traditional practices aimed to stimulate milk production or to castrate male animals are included.

To favour diuresis, in Madrid, a *sahumerio* (the smoke produced by the combustion of aromatic plants or other substances) composed of pieces of *Ruta montana* (L.) L., *Thymus vulgaris* L. and *Foeniculum vulgare* Mill. was prepared and inhaled by the affected animals (Aceituno-Mata 2010). The decoction of the root of *Smilax aspera* L. is considered diuretic for animals in the Montseny (Catalonia) (Agelet et al. 2000; Bonet 2001) and Asturias (San Miguel 2004).

When animals presented blood in the urine (haematuria), a decoction of the root of *Urtica dioica* or a tisane of *Tilia platyphyllos* Scop. was used in Asturias (San Miguel 2004).

In the Western part of Granada, to help urinate the mares, mules and cows suffering from cystitis they introduced to them a bundle of stems of *Scirpoides holoschoenus* in the vagina (Benítez 2009; Benítez et al. 2012). In León people gave the cows *Digitalis purpurea* L. leaves to eat in cases of urinary retention (García Jiménez 2007).

The existence of many topical remedies for the treatment of mastitis (a major problem in non-organic production) was recorded. Poultices of fresh leaves of *Borago officinalis* L., as well as massages with the liquid resulting from its decoction, have been applied on the inflamed udders in Extremadura (Penco 2005) and Menorca (Moll 2005). The aerial parts macerated in oil of *Jacobaea vulgaris* Gaertn. in the Arribes del Duero (González et al. 2011a), and of *Hypericum perforatum* L. in the Alt Empordà and the Montseny (Catalonia) (Bonet 2001; Parada 2008), were applied as a liniment or ointment with the same aim. In Terra Chá, they applied a decoction of leaves of *Verbascum thapsus* on the udders or rubbed them with the hot leaf and soaked in milk (Anllo 2011). In the Picos de Europa area, they crushed *Laurus nobilis* L. fruits and the plaster obtained was spread on the udders (Lastra 2003). The aim of this type of treatment against mastitis was to rapidly cure the inflammation of the udder, preventing damage to the gland and further infection, and also to allow the sale of uncontaminated milk (Fig. 17.3).

In Tenerife, the infusion of *Chamomilla recutita* (L.) Rauschert has been used to treat uterine prolapse, applying it by washing the uterus (Álvarez Escobar 2011).

The flexible and resistant bark of *Daphne gnidium* has been used as a tool to castrate male animals, especially kids (e.g., Molero Mesa et al. 2001; Criado et al. 2008; Verde et al. 2008; Velasco et al. 2010), as a tie to stop the descent of the testicles.

Fig. 17.3 Curing mastitis in a goat. (Photograph: A. Verde)

17.4.7 Conception, Pregnancy and Labour

This sub-section includes remedies related to the stimulation of the ovarian and oestrous cycles; to complications in pregnancy (such as miscarriages) and during labour; or postpartum affections, such as placenta retention or internal postpartum inflammations, or to facilitate the recovery process of the female. Plants with recognised aphrodisiac and anaphyrodisiac properties and those used as an abortifacient are also included.

In La Coruña, the decoction of bark of *Fraxinus excelsior* L. has been used as a sexual stimulant for cows (Latorre 2008). In Albacete, the aerial parts of the endemic *Dictamnus hispanicus* Webb ex Willk. were stored dried and then chopped and mixed with the rams' fodder to promote the "work" of these studs (Rivera et al. 2008; Verde et al. 2008) and that of the young ewes so that they would go into heat (Verde et al. 1998; Verde 2002). In the Sierra de Cazorla (Jaén) *Dictamnus albus* L. was the species used by the shepherds to provoke heat in goats, giving them its leaves to eat directly (Fernández Ocaña 2000).

In Terra Chá, they gave the cows the decoction of the capsule of *Papaver somniferum* L. to drink as an aphrodisiac, in order that they mate more easily (Anllo 2011). To favour the pregnancy of sows and ewes, in Jaén and Alicante *Thapsia villosa* L. was used as an aphrodisiac. They gave them its basal leaves to eat (dried and mixed with salt) or the decoction of the whole plant to drink (Guzmán 1997; Fernández Ocaña 2000; Pedauyé et al. 2014). In contrast, in Pallars they consider that *Hedera helix* L. has an anaphyrodisiac effect in the rabbits that consume it, reducing their sexual appetite (Agelet 1999).

In some regions, rue (*Ruta angustifolia* Pers., *R. chalepensis* L.) has been used to stimulate fertility in livestock (e.g., San Miguel 2004; Verde et al. 2008), sometimes simply hanging from the ceiling of stables bunches made with its branches (Fig. 17.4).

Sometimes it is necessary to help female animals to expel the placenta and fetal membranes after labour. In Spain retention of the placenta is treated by giving the cows, ewes and goats different fresh plant parts: leaves of *Hedera* spp. (e.g., Lastra 2003; Pardo-de-Santayana 2004; Velasco et al. 2010; González et al. 2011a), seeds of *Paeonia broteri* Boiss. & Reut. (Verde et al. 2008), or branches of *Thymelaea hirsuta* (L.) Endl. (Martínez and Martínez 2011). However, the most frequent practice is to force the animals to take a tisane obtained by decoction or infusion of different plant parts; for example: *Chamomilla recutita* inflorescences (Batet et al. 2011), the aerial part of *Viscum album* L. (Lastra 2003; San Miguel 2004; Pardo-de-Santayana 2008; Akerreta et al. 2010; Pascual Gil 2013), *Glechoma hederacea* leaves (Latorre 2008; Anllo 2011), the leaves or the inflorescence of *Verbascum thapsus* (Agelet 1999), *Paeonia broteri* rhizomes (González et al. 2011a), *Cistus albidus* L. leaves (Benítez 2009; Benítez et al. 2012), *Artemisia vulgaris* L. flowered aerial parts (Latorre 2008), or the aerial part of *Ruta montana* (González et al. 2011a).

Fig. 17.4 In Spain, the custom of the people of hanging "bouquets" of certain herbs from the ceiling of livestock quarters still continues to this day. (Photographs: A. Verde and J. A. González)

In some cases, to expel the retained placenta, they brewed complex concoctions. In the Sierra de Guadarrama (Madrid) the goatherds prepared a beverage containing seeds of *Paeonia broteri* (an odd number of them, seven if the goat was small, and nine if it was large), rhizome of *Gentiana lutea* L., *Chamaemelum nobile* (L.) All. inflorescences and olive oil (Aceituno-Mata 2010). In Granada they gave the females a decoction of *Sideritis hirsuta* L. and *Phlomis purpurea* L. together with bark of *Quercus ilex* L. and onion (Benítez 2009).

To treat internal inflammations postpartum, in Pallars they gave the females a tisane of the fruits of *Fraxinus excelsior* to take or put a poultice of their bark boiled in olive oil if fruits were not available (Agelet 1999). In Terra Chá, they gave the sows a decoction obtained with the leaves of *Betula alba* L. (Anllo 2011).

The decoction of the inflorescences of *Santolina chamaecyparissus* L. was used as an antiseptic during the puerperium in Mallorca, applied by enemas (Carrió et al. 2012). *Vaccinium myrtillus* L. was used in Terra Chá for recovering after an abortion (Anllo 2011).

Finally, the decoction of some plants has traditionally been used as an abortifacient. Females were forced to drink different concoctions; for example, in Huelva the decoction of *Verbascum sinuatum* leaves (Gómez Cuadrado 2011), in Albacete of *Daphne laureola* L. leaves (Verde 2002; Verde et al. 2008), in Huesca of *Asphodelus albus* Mill. roots (Villar et al. 1987), or in the Montseny of *Mercurialis annua* L. and *M. ambigua* L. fil. (Bonet 2001).

17.4.8 Respiratory System

A good number of plant-based remedies to treat various diseases of the respiratory system, or to relieve associated common troubles as cold or pneumonia, have been documented.

In Granada colds in equines are cured by giving them the basal part of the stems of *Scirpoides holoschoenus* to eat, raw or cooked, crushed and mixed with pork lard (González-Tejero et al. 1995; Benítez 2009). In Navarra (Akerreta et al. 2010, 2013) and Terra Chá (Anllo 2011) people gave the animals a decoction of the root of *Althaea officinalis* L.

To treat bovine cough, in La Coruña, inhalation of the cooking vapours of laurel leaves has been used (Latorre 2008).

To treat pneumonia in cattle, in Cantabria people gave the animals a decoction of the rhizome of *Gentiana lutea* to drink (Pardo-de-Santayana 2008), in Lugo an infusion of *Glechoma hederacea* and *Urtica dioica* (Romero Franco et al. 2013), and in Zamora smoking the animals burning (with sugar, to generate smoke) the aerial part of *Lavandula pedunculata* (Mill.) Cav. (González et al. 2011a).

In order to alleviate throat affections in equines, in Huesca the decoction of the root of *Ulmus minor* Mill. was used (Villar et al. 1987). A decoction of the *Valeriana officinalis* root, together with camphor, has been used for asthmatic animals in La Coruña (Latorre 2008).

17.4.9 Endocrine, Nutritional and Metabolic Diseases

Remedies for the treatment of gout and anaemia have been documented. In Tenerife, some farmers cured gout in livestock, supposedly produced by the intake of certain plant species considered "warm", with an infusion of *Rumex lunaria* L. (Álvarez Escobar 2011).

In the Sierra de Segura and La Manchuela district (Albacete and Cuenca provinces), the shepherds greatly appreciate *Aphyllantes mospeliensis* L. They give it to sheep and goats that suffer from anaemia to eat (Verde 2002; Fajardo et al. 2007).

17.4.10 Certain Disorders Involving the Immune Mechanism

To cure gaseous lymphadenitis in goats, in Tenerife, they applied a poultice of crushed garlic and pepper (Álvarez Escobar 2011).

In cases of spleen diseases, the decoction of the leaves of *Hepatica nobilis* has been used in the Montseny as a splenic analgesic (Bonet 2001).

17.4.11 Musculoskeletal System

Most of the remedies included in this sub-section have to do with treatments related to leg breaks, bruises, contusions, sprains, joint pain, and lameness, as well as horn injuries.

Sheep and goats sometimes have accidents, breaking a leg for example. More experienced shepherds (and normally the older ones) immobilize the limb and cure it by in situ use of certain bush species. For example, in the Arribes del Duero, after resetting the bone, the leaves of *Cistus ladanifer* L., glued with their own exudate (labdanum), are placed on the limb, which is splinted with two branches (leaf-free) tied together with twine (sometimes improvised from the bark of *Daphne gnidium*, a plant also used for splinting). If this species is not present in the area, *Cytisus multiflorus* (L'Hér.) Sweet is used (González et al. 2011a).

To repair broken bones, in Campoo (Cantabria) poultices of the cooked and crushed bulb of *Lilium martagon* L. were applied (Pardo-de-Santayana 2008), and in León those poultices were used as a "glue" when a cow broke a horn: "they crushed the bulb, spread the plaster obtained on the two parties to be welded and bandaged the broken horn" (García Jiménez 2007).

In Huesca, Gerona, Salamanca, Cuenca and Albacete, *Hypericum perforatum* was cooked (the whole plant), and people placed on the inflamed areas by blows and contusions hot cloths soaked with the obtained decoction (Ferrández and Sanz 1993; Verde 2002; Fajardo et al. 2007; Parada 2008; Velasco et al. 2010). *Marrubium vulgare* L., fresh and chopped, was applied in Huesca as a poultice for contusions and inflammation in animals (Villar et al. 1987; Ferrández and Sanz 1993). For the swelling of animal knees, plasters of the leaves of *Verbascum thapsus* were applied in La Coruña province (Latorre 2008).

In Albacete, with the decoction of *Thapsia villosa* (whole plant) they rubbed the legs of animals, mainly pigs, to treat rheumatism (Rivera et al. 2008). In Campoo *Sonchus asper* (L.) Hill was given to pigs affected by this condition (Pardo-de-Santayana 2008).

17.4.12 Skin and Subcutaneous Tissue

Undoubtedly in this sub-section wounds are the ailment that is treated with a greater number of different remedies and plants. Also, we bring together different remedies to treat furuncles, dermatitis or different conditions in the animal hooves.

Decoctions of antiseptic and vulnerary plants are used to clean wounds, reduce inflammation, and accelerate the healing of the gashes produced, for example, by the tip of a ploughshare, or grazes produced by harnesses of beasts of burden, mainly donkeys and mules. Generally, the resulting liquid is applied onto the affected area (Fig. 17.5). For example, some popular remedies are prepared with

Fig. 17.5 Washing a leg wound in an ewe with a decoction of *Sideritis tragoriganum* Lag. (Photograph: José Fajardo)

Sideritis hirsuta aerial parts (e.g., Fernández Ocaña 2000; Fajardo et al. 2007; Rivera et al. 2008; Verde et al. 2008; Benítez 2009), *Verbascum thapsus* leaves (e.g., Villar et al. 1987; Criado et al. 2008; Velasco et al. 2010; Anllo 2011; Benítez et al. 2012), *Plumbago europaea* L. aerial parts (González-Tejero 1989; Mesa 1996; Verde 2002), *Ecballium elaterium* (L.) A. Rich. fruits and roots (Mesa 1996; Guzmán 1997; Casado Ponce 2003), and different parts of *Hypericum perforatum* (e.g., Ortuño 2003; Fajardo et al. 2007; Verde et al. 2008; Aceituno-Mata 2010; Tejerina 2010; Velasco et al. 2010; Gómez Cuadrado 2011; González et al. 2011a).

Other interesting remedies for pigs are used in the traditional *matanza* (slaughter of swine and preparation of hams and sausages, etc., for later curing), for which a fattened castrated male pig is required. Currently, pigs are castrated by qualified veterinarians, but in the past, it was the most experienced member of the family who performed this duty. Even then, the procedure could lead to serious health problems for the animal. To avoid wound infection and inflammation the succulent leaves of *Umbilicus rupestris* (Salisb.) Dandy (applied directly) (Gallego and Gallego 2008; González et al. 2011a), the decoction of several *Sideritis* species (e.g., Rivera et al. 2008; Benítez 2009) or *Hypericum perforatum* flowers (Fernández Ocaña 2000) were used.

Capparis spinosa L. roots have been used in Almería province for the treatment of cracks and ulcers in the hooves of animals, by daily washing with the decoction (Martínez Lirola et al. 1997).

To cure pimples of equines and other domestic animals, in Badajoz poultices were prepared with the densely hairy leaves of *Cynoglossum creticum* Mill., which were applied directly on the affected area (Penco 2005). In La Coruña, they used the hot leaves of *Verbascum thapsus* to mature the abscesses, putting them on the affected area as a poultice for a few hours (Latorre 2008).

Baths with the decoction of *Buxus sempervirens* L. roots were applied to treat chilblains in animals in the Valley of Camprodon (Catalan Pyrenees) (Rigat 2005).

In Albacete, a decoction of *Calendula arvensis* L. was used in equine coat care (Rivera et al. 2008).

17.4.13 Nervous System

Practically most of the remedies corresponding to this sub-section are aimed at tranquilizing the animals or as an analgesic.

Some concoctions or tisanes have been prepared to give overexcited animals, especially cattle, as a tranquilizer. An infusion of *Tilia platyphyllos* or the decoction of *Ruta chalepensis* has been used in the Picos de Europa (Lastra 2003); an infusion of *Malva sylvestris* or a preparation made with the aerial part of *Papaver somniferum* and potassium nitrate boiled in two liters of water were used in La Coruña (Latorre 2008).

In Mallorca, the use of *Papaver somniferum* as a sedative and analgesic in animals has been registered, through the oral administration of a tisane of its aerial parts (Carrió 2013).

17.4.14 Sensory Organs

Only remedies for the treatment of diseases of the eye and adnexa have been documented. To treat corneal leucoma in animals, corneal ulcers caused by injury to the eye by vegetation, they washed the eyes of the animals with decoctions or infusions of different plant species. For example, in Northwestern Spain with the inflorescences of *Chamaemelum nobile* (Pardo-de-Santayana 2004; Lastra 2003; González et al. 2011a), in Albacete with the aerial part of *Sideritis tragoriganum* Lag. (Sánchez López et al. 1994), and in Tenerife and Lugo with *Chelidonium majus* (whole plant) mixed with honey (Blanco 1996; Blanco et al. 1999; Álvarez Escobar 2011).

The hollow stem of some grasses (e.g., *Secale cereale* L., *Dactylis glomerata* L., *Stipa tenacissima* L., *Piptatherum miliaceum* (L.) Coss., *Deschampsia media* (Gouan) Roem. & Schult.) has been used as a remedy to cure corneal keratitis (e.g., Mesa 1996; Guzmán 1997; Martínez Lirola et al. 1997; Verde 2002; Benítez 2009; Benítez et al. 2012). It is one of the most complex operations of the folk veterinary medicine. The method consists of opening the mouth of the animal and introducing a piece of stem (equal in size to the distance that separates the nostril from the eye) by the choanae or posterior nasal vents. Then the cane is broken and the excess portion is removed, so that it does not bother the animal. Shepherds say that later, as the cane is rotted, the disease disappears. This remedy was considered very effective and it was very frequent until 20 or 30 years ago. Since then it has been disappearing, due to the work of veterinarians, however it is still carried out sporadically.

As an ocular antiseptic, in Huesca and Tenerife eye washes of the infusion of *Chamomilla recutita* inflorescences have been used (Villar et al. 1987; Álvarez Escobar 2011), of *Santolina chamaecyparissus* in Mallorca (Carrió 2013), and of *Chelidonium majus* flowers in Terra Chá (Anllo 2011). To treat ocular infections in equines, a plaster of *Helleborus foetidus* L. behind the ears of the animal was applied in Pallars (Agelet 1999).

17.4.15 Other Infectious and Parasitic Diseases

In this sub-section we report some popular herbal remedies for the treatment and prevention of important diseases of bacterial origin (erisypelas, dysentery, tuberculosis, coryza), certain zoonotic bacterial diseases (anthrax, glanders, brucellosis), viral infections (pox, distemper, herpes), mycosis (ringworm, tinea), helminthiasis, infestations by ectoparasites (scabies, myiasis), and arthropod-borne diseases.

Glanders, caused by *Burkholderia mallei* (a Gram-negative bacillus) and known as *muermo* in Spain, was treated in the mountains of Jaén with a decoction of branches of *Clematis vitalba* L. (Fernández Ocaña 2000). In other cases, this disease was treated by remedies based on the inhalation of smoke from plants with a penetrating smell. Examples are *Ferula communis* L. or *Thapsia villosa*, which in the past were especially used in the province of Zamora (González et al. 2011a).

To treat *moquillo*, the name used to refer to avian infectious coryza (caused by *Avibacterium paragallinarum*, a Gram-negative bacterium), in the Arribes del Duero the chickens were bathed in the water resulting from the decoction of the seeds of *Lupinus albus* L. (González et al. 2011a).

In this same area, to treat scald or hoof rot, a ruminant hoof disease in sheep that leads to lameness and that is attributed to excessive moisture in the area where the animals graze, they boiled the aerial parts of *Scrophularia canina* L. and applied the decoction to their animals' hooves (González et al. 2011a). The same decoction (added to food) was used as a preventive remedy against the *mal rojo* (swine erysipelas), caused by the Gram-positive bacillus *Erysipelothrix rhusiopathiae* (González et al. 2011a). Unlike this, in Mallorca they applied to the pigs a poultice made with *Clematis flammula* and wheat bran (Carrió et al. 2012; Carrió 2013).

In Lugo, the stems and leaves of *Apium nodiflorum* (L.) Lag. were macerated in milk with sugar, and the resulting liquid was given to take the pigs overnight to combat dysentery, and the decoction of the roots of *Althaea officinalis* was used to cure bovine tuberculosis (Anllo 2011).

Regarding viral diseases, the decoction of *Viscum album* was given to sows to drink in Pallars for 3 or 4 days after labour. In this way, through mother's milk, their young were immunized against swine pox (Agelet 1999). In Ibiza, they used *Dittrichia viscosa* (L.) Greuter when herpes appeared on the neck of the horses.

To do this, they washed the area with the water used to cook this tough plant (Torres 1999).

On the other hand, we noted the use of different plants (owing to their toxicity or penetrating smell) as remedies for the disinfection of hen-houses, stables, etc., and for the treatment of ectoparasites of domestic animals (simple and effective plant-based remedies are employed for the control of vector-borne diseases).

Of special importance are the lice infesting poultry. Known as "chewing lice" (Phthiraptera, Amblycera), they feed on pieces from the birds' feathers or skin and cause a considerable degree of discomfort and restlessness in the birds (heavy infestations can cause weight loss and reduced egg production). Even today, the main way of eliminating such lice in Spain is with *Daphne gnidium*. It is used by spraying the floor of hen-houses with the water in which its root has been submerged previously (the root is macerated in cold water for a day) or with the liquid obtained from a decoction of a few branches (e.g., Verde et al. 2000; González et al. 2011a, b).

Regarding other external parasites, some plants were used as a very efficient remedy for exterminating fleas (the group that was of greatest concern among the inhabitants of the Spanish rural communities). For example, the roots and branches of *Daphne gnidium* were used in the past to prevent infestations of fleas in stables. The root of this species was submerged in water until the water turned black, after which the extract was sprayed on the ground. Bunches of green shoots were sometimes hung up or spread in shepherd huts as additional means of control (e.g., González et al. 2011a, b) (Fig. 17.4). Similarly, the bulb of *Drimia maritima* (L.) Stearn was ground and soaked in water (González et al. 2011a) and the aerial parts of *Plumbago europaea* were cooked (Verde 2002), and these were used to spray the stables. Unlike this, in Cantabria calves infested by lice were washed directly with a decoction of *Gentiana lutea* rhizome (Pardo-de-Santayana 2004, 2008).

To cure mange in sheep and goats, in Jaén they made an ointment with resin of *Cistus albidus* and pork lard (Fernández Ocaña 2000); in Madrid a decoction of crushed branches of *Cytisus scoparius* (L.) Link was applied topically (Aceituno-Mata 2010); in Southeastern Spain people bathed the animals or rubbed the affected areas with the liquid resulting from cooking the shoots and tender stems of *Retama sphaerocarpa* (L.) Boiss. and *Juniperus oxycedrus* L. (Verde 2002; Verde et al. 2008); in Granada, the root of *Plumbago europaea* was crushed and macerated in water, and with a scouring pad the animal's body was rubbed with the resulting liquid (Benítez 2009). In a different way, in Navarra fresh branches of holly (*Ilex aquifolium*) were hung from the ceiling of the stables to combat scabies (Akerreta et al. 2010, 2013).

A decoction of *Sambucus ebulus* L. (whole plant) was used in Huesca to cure sarcoptic mange in dogs (Ferrández and Sanz 1993). In Pallars the shepherds prepared a lotion based on *Aconitum napellus* L. and tobacco that they applied on the skin of sheep and goats to eliminate mites and fungal infections (ringworm) (Agelet 1999).

In Terra Chá, they prepared an infusion with roots of *Fragaria vesca* L. to expel the intestinal worms in livestock (Anllo 2011).

Finally, herbal remedies for treating myiasis were documented. To remove the *rosones* from the anal sphincter (urogenital myiasis) of donkeys and mules, in the Arribes del Duero the parasitized animals were given the fruits (dried) of *Rumex pulcher* L. (González et al. 2011a). To treat cutaneous myiasis (*cocos*), the latex from *Euphorbia helioscopia* L. in Salamanca (González et al. 2011a), or a poultice of crushed leaves of *Digitalis purpurea* in Granada (González-Tejero 1989), were applied topically on the affected area. However, more important than these are the traditional remedies based on magical-curative rituals. For example, in Salamanca the large basal leaves of *Verbascum pulverulentum* were placed, in the shape of a cross, on the track of the cow that suffered the infestation (Velasco et al. 2010).

17.4.16 Tumor Diseases

Some herbal remedies for the treatment of undefined neoplasms in animals have been recorded. In Castellón they treated the tumors of equines by means of a tisane from the aerial parts of *Dittrichia viscosa* (Mulet 1991).

Paeonia broteri was used in Jaén in the healing of skin tumors, for which people applied the water resulting from the decoction of the whole plant on the skin of the affected animals (Guzmán 1997).

17.4.17 Symptoms, Signs and Abnormal Clinical and Laboratory Findings

We present some examples of herbal remedies used to treat symptoms and signs not elsewhere classified (fever, undefined pain, loss of appetite, weakness) and less well-defined animal conditions.

In Jaén *Ruta angustifolia* was used to treat the so-called *fiebres del chinchón*, swine fevers possibly produced by flea stings (Guzmán 1997). In Galicia, they used *Verbascum pulverulentum* to treat the animals when they had “cerebral fever” (watering eyes, stuffy nose). After boiling the plant, a container with the boiling liquid was placed under the animal, which was covered with a blanket and forced to inhale the vapours (Romero 2001). In Galicia, the aerial part of *Helleborus foetidus* was applied fresh as a febrifuge in cases of pneumonia (Romero Franco et al. 2013).

In the Canary Islands, the succulent plant *Kleinia neriifolia* Haw. was used against the *gogo*, a very contagious disease that affects the tongue and throat of hens, and that causes them to cluck in a unique way. For this, several slices of the thick stem of this endemic shrub were chopped and thrown into the drinking water of the animals (Perera López 2005; Álvarez Escobar 2011).

In Murcia a decoction of *Citrullus colocynthis* (L.) Schrad. was used to relieve pain in domestic animals (Rivera et al. 2008).

The consumption of branches and leaves of *Buxus sempervirens* has traditionally been considered a good restorative or tonic for sheep in Pallars (Agelet 1999). In the Ribagorza district (Huesca), the maceration in water of *Gentiana lutea* rhizome was given to domestic animals to drink on an empty stomach for 9 days against chronic exhaustion (Villar et al. 1987).

17.4.18 Intoxication and Poisoning

Some traditional remedies destined to alleviate the troubles (pain, itchiness, swelling) usually caused by contact with poisonous animals and plants, and to cure accidental poisoning by and exposure to venomous animals (especially viper bites) or noxious substances, as an antidote, have been recorded. In the recent past many of these remedies were well known; in particular, those based on the application of a poultice made with different plant parts on the zone of the bite.

To treat viper bites, in the Arribes del Duero a poultice made with the boiled aerial parts of *Scrophularia canina* mixed with lard was used (González et al. 2011a). In the Sierra do Courel fresh *Corylus avellana* leaves were applied directly (Blanco et al. 1999); in Catalonia people rubbed the area with an ointment made with olive oil and *Nepeta cataria* L. (Agelet 2008), or prepared a poultice with the cortical parenchyma of *Fraxinus angustifolia* Vahl (Agelet 1999; Agelet et al. 2000).

To relieve the itchiness caused by insect bites and stings, in Albacete and Alicante they applied to the animals a decoction of *Retama sphaerocarpa* branches (Rivera et al. 2008; Verde et al. 2008). For horsefly stings specifically, in Terra Chá people applied the poultice obtained by macerating leaves of *Verbascum thapsus* in silver nitrate (Anllo 2011).

In the Canary Islands, the infusion of the root or leaves of *Rumex lunaria* served as an antidote for goats against poisoning caused by excessive intake of certain plants, such as *Bituminaria bituminosa* (L.) C.H. Stirt. (Siemens Hernández 1981; Noda Gómez 2003).

Finally, in case of livestock poisoning by strychnine, as an emetic, in Pallars it was recommended that the animal take an emulsion of *Fraxinus excelsior* bark boiled in olive oil (Agelet 1999).

17.5 Animal Feeding

In Spain, apart from livestock diseases, their owners are most worried about their domestic animals' nutrition, since without sufficient forage, it is not possible to sustain them, and no benefits can be obtained. A total of 1310 plant species have been used for animal feeding, both cultivated and gathered from the wild. The use of wild plants for this purpose is of considerable ecological importance since historically it has contributed to the maintenance of an agricultural-livestock model involving the rational use of plant resources and the creation of a landscape of great natural value (see Molinero 2013).

Spain is characterized by a low degree of livestock stabling where the animals themselves show their preferences for certain types of plant. Animals reared by their herders in the open are taken to sites where these species are available. For example, the *majadales* (lively and dense pastures dominated by the grass *Poa bulbosa* L., located on gentle slopes with shallow soil and fresh) are maintained precisely because of the treading and intensive grazing performed by the livestock (Sánchez et al. 2006). However, many of the inhabitants of rural areas continue to exploit small plots of land for growing forage crops (cabbage, pumpkins, maize, etc.) and harvest plants that, by observation, they know to be palatable to the livestock and are highly appreciated for the feeding of stabled animals. There is a good number of wild species for use as forage that are collected for livestock feeding.

Among these forage plants, many species are weeds that appear on crop-growing plots (e.g., *Convolvulus arvensis* L., *Stellaria media* (L.) Vill., *Portulaca oleracea* L.). By collecting these, two aims are met: food for the animals and de-weeding.

In general, these plants are offered to all species of animals, although the three classes of livestock for which most wild forage plants are collected, since the animals are not allowed roam free, are pigs, rabbits and poultry.

In Spain, many families raise a pig for the annual *matanza* (slaughter). To feed such animals the families grow cabbages or pumpkins, but they also collect several wild plants, many of them important Mediterranean forage plants owing to their nutritional properties (e.g., Ayan et al. 2006). Besides the species mentioned above, one of the most important wild forage plants is *Asphodelus albus* and other similar species of the genus, whose basal leaves are given to swine. A preparation of *Urtica dioica* (nettles, *ortigas* in Spanish) shoots and flour is very popular, and indeed there are folk sayings in this respect, such as one reported by Gallego and Gallego (2008) in many villages of the province of Zamora: "*El que quiera un buen cebón, que le dé en mayo ortigón*" (approx.: "*If you want your pig in the best of fettle, give it in May a load of nettle*"). Moreover, although the swine are not taken out of their pens to take advantage of the *montanera* (where they are allowed to eat acorns out on free-range land) the fruits of some species of Fagaceae are collected: *Fagus sylvatica* L. (*hayucos*, beeches); *Castanea sativa* Mill. (*castañas*, chestnuts); *Quercus faginea* Lam.; *Q. ilex* L. subsp. *ballota* (Desf.) Samp.; *Q. pyrenaica* Willd., *Q. suber* L. (*bellotas*, acorns).

Among the wild plants used to feed rabbits and poultry *Convolvulus arvensis* and *Stellaria media* stand out. These two herbaceous plants are characterized by their high content in essential elements, vitamins and proteins (Ayan et al. 2006).

Regarding preparation, in most cases, the plants are offered raw to the animals. Only a few species are cooked, such as nettles (owing to their urticariant action) and *acederas* (*Rumex acetosa* L. and other species of the genus). In these cases, this is most likely done to avoid intoxication, owing to this species' high content in oxalic acid (see Villar and Ortiz Díaz 2006). Also, in many regions the tradition of mixing wild forage plants with flour or bran persists, since such mixtures afford a very complete food for the livestock. Casado and Martínez (2010) report in Salamanca province the preparation of a specific mixture for swine, with *Sonchus oleraceus* (L.) L., *Chenopodium album* L., *Convolvulus arvensis*, *Portulaca oleracea* and oat flour or bran.

In some cases, the animals' diet is supplemented for specific purposes. For example, *Lonicera etrusca* Santi is given to goats to improve their milk production in Salamanca (Velasco et al. 2010; González et al. 2011a), and in many Spanish regions *Urtica urens* L. is mixed with feed for hens so they will lay eggs earlier in their life-span and so the eggshells will be harder (e.g., Verde et al. 1998; Tardío et al. 2002; Velasco et al. 2010; González et al. 2011a). In Huesca, people feed hens with fresh leaves of *Chelidonium majus*, in order that they lay eggs with much more yellow yolk (Villar et al. 1987). In Pallars, the seeds of *Anagallis arvensis* L. were given to the red-legged partridges to eat as being healthful, enhancing the song and a good plumage status (Agelet 1999).

The branches of some arboreal and shrub-like plants are cut by shepherds to feed their flocks of goats and sheep. The branches from this "pruning" are known as *ramón* or *rohíjo*, and they are gathered as a nutritional supplement when there is pasture available or are stored for use when it is not. Among the trees, riverbank species are outstanding, for example *Celtis australis* L., *Ulmus minor* or *Fraxinus angustifolia*. Among them, *Fraxinus angustifolia* branches (*ramón de fresno* or *fresniza*) are considered to have some medicinal properties. At the end of the summer, the finest branches (with leaves) are gathered and stored for the winter; they are especially indicated for weak or sick animals, since the compounds in them act as a tonic (e.g., Aceituno-Mata 2010; Velasco et al. 2010; González et al. 2011a; Blanco 2015).

On the other hand, the consumption of some plant species is avoided. For example, in Cantabria *Trigonella foenum-graecum* L., although it was considered as very good fodder for the cows that were breeding, the consumption of this plant was avoided because it gave a bad taste to the milk (Pardo-de-Santayana 2008). In La Coruña, it is said that if hens are given many leaves of *Lactuca virosa* L. then they do not lay eggs (Latorre 2008).

17.6 Animal Bedding

Although straw is mainly used currently for animal bedding purposes, many wild vascular plants have been also used (and in some cases still are). The leaves of certain tree species such as *Quercus ilex*, *Fagus sylvatica*, *Arbutus unedo* L. or *Pinus canariensis* C. Sm. ex DC. in Buch, and the branches of abundant bushy species (e.g., *Cytisus multiflorus*, *C. scoparius*, *Genista florida* L., *Launaea arborescens* (Batt.) Murb.) have been commonly used.

Some species are attributed to have "thermal" properties. The large fronds of *Pteridium aquilinum* (L.) Kuhn in Kerst. are cut, dried, and strewn over the floor of stables, especially in summer since they provide a cooler environment for the livestock (e.g., San Miguel 2004; Blanco and Díez 2005). Also, in winter the soft twigs of *Cistus ladanifer*, are sometimes used since some people consider them "the plant that warms" (González et al. 2011a).

Other species are attributed to have curative properties. Thus, rue (*Ruta angustifolia*, *R. chalepensis*) has been used to cure porcine erysipelas; they threw branches of these plants on the floor of sties (Martínez Lirola et al. 1997; Fajardo et al. 2007). In the same way, branches of *Sorbus aucuparia* L. were placed inside the pigsty as an animal bedding with antiviral effect in the Alt Ter (Gerona), especially against the swine blue eye disease (Rigat 2005; Carrió et al. 2012).

Also interesting is the specific use of some of these "beds" for their insecticide activity. To repel fleas and other annoying insects (lice, ticks, flies), in Almería the aerial parts of *Artemisia barrelieri* Besser were used as insecticide for livestock, either by placing a bunch in animal quarters or using them as a bed (Martínez Lirola et al. 1997); in western Granada province the aerial parts of *Phlomis purpurea* have been thrown on the floor of the stables (Benítez 2009), and in many regions *Daphne gnidium* branches were used (e.g., Fernández Ocaña 2000; Molero Mesa et al. 2001; Gallego and Gallego 2008; Tejerina 2010).

Finally, the trodden remains of these plant species replaced sporadically, hold urine and excrement, thereby providing first-class manure for the organic treatment of vegetable plots and other crop-growing lands.

17.7 Conclusions

Concerning their ethnoveterinary use, a plethora of plant-based remedies and practices have been amassed in Spanish EVM. A high number of vascular plant species were, and some still are, used and this is a heritage that could constitute a fundamental step for the discovery and isolation of natural extracts from plants in the search for new and low-cost drugs for domestic animals. Likewise, the data documented invite further research to determine the validity of these folk remedies (in terms of safety and effectiveness), and it is also necessary and important to conduct studies aimed at better determining and documenting traditional plant uses in the field of EVM. In particular, we must continue to advance such knowledge in some isolated rural areas since, from the ethnobotanical point of view, these are very interesting human communities owing to their poor economic development and the fact that it is still possible to find a highly valuable traditional veterinary knowledge (TVK). Older inhabitants, and in particular those tightly linked to the pastoral culture, are the people with the best knowledge of herbal remedies to cure livestock, which are the pillars on which the economy of the territory rests.

This type of knowledge may soon be lost due to the abandonment of traditional practices. Among the causes of the declining use of the veterinary herbal remedies documented, as well as loss of TVK, are the progressive depopulation of rural areas, the disappearance of draft animals (replaced by machinery) and the generalization of veterinary care. Moreover, this review highlights the importance of TVK in safeguarding biocultural heritage. This knowledge forms part of the "other diversity", of what we call Cultural Diversity. The veterinary uses and practices documented only survive in the memories of elderly people, such that it would be highly recommendable to hold workshops or meetings with elderly people from the rural setting to conserve ethnobotanical heritage, activities that at the same time would provide an ideal framework within which it would be possible to improve the quality of life of elderly people in the sense of enhancing their self-esteem and boosting their feelings of social usefulness, since they would be sharing their traditional knowledge with other younger generations.

Finally, we emphasize that the set of practices collected helps in understanding Spanish EVM as a whole and at the same time allows for a global perspective on future therapeutic practices and related research on them. It must be taken into account that a future still exists for traditional cattle ranchers and shepherds in the context of current European agricultural policies, and that they can contextualize and “learn to unlearn” values of EVM. All this can lead to a paradigm shift in ethnobotanical studies; if we understand plant-based remedies not only as therapeutic resources but also as intellectual and emotional ones. This change will favour a cultural change and a mentality oriented to new ways of understanding extensive farms, transhumance and the relationship with the animals, consistent with preventive veterinary medicine.

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