DESERTIFICATION COMBAT AND FOOD SAFETY

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Desertification Combat and Food Safety

The Added Value of Camel Producers

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Desertification Combat and Food Safety
B. Faye and P. Esenov (Eds.)
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Preface

The international workshop on Desertification Combat and Food Safety – The Added Value of Camel Producers was a good opportunity for the meeting between desert and camel scientists from Western European countries, Mediterranean countries and Central Asian Republics. Scientists from Central Asia are confronted with the demanding challenge of desertification and maintenance of animal productivity in order to satisfy human requirements both in quantity and quality. The problem is complex and solutions need a multidisciplinary investment. The knowledge of the desertification process and the place of animal production in desert ecosystem is in increasing in many countries. New approaches and methodologies have been implemented for a better observation and understanding of the situation. The present workshop contributes to the exchange between scientists in order to allow access to those new approaches and methodologies by all desert and camel scientists in the involved countries.

Most of the foreign participants to the workshop are well-known in the camel sciences community. All of them have significantly contributed to a better understanding of camel biology, camel productivity or of the camel as an element of the desert ecosystem. The confrontation of the research achieved in those countries with the scientific activities achieved in Central Asia is quite important. It contributes to the improvement of the methods used in those countries and at the very least helps the scientists from Central Asia to access more recent publications and to reach the international standard for publications. A great effort is still necessary and this workshop has to be continued by specific collaboration between research institutes or universities. The meetings and informal exchanges allowed by the workshop were a first step towards future collaboration.

Some final recommendations were proposed as is usual in such scientific meetings. However, recommendations are fruitful if all participants play their part in the achievement of them, inside their discipline, or field study, and if we are collectively able to convince policy makers to support such and such research or development aspect.

The co-directors of this workshop are indebted to NATO and secondly to the French Embassy for their support in this workshop. Three institutes were involved in the general organization: one French (French Agricultural Research Centre for International Development-CIRAD) and two Turkmen Institutes (National Institute of Desert, Fauna and Flora – NIDFF, and National Institute of Livestock and Veterinary Medicine (NILVM). Their collaboration was able to overcome the traditional difficulties of organizing a meeting gathering forty scientists from seventeen different countries.

Dr Bernard FAYE and Dr Palmated ESENOV
Co-directors and Scientific editors

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Desertification Combat and Food Safety
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Camel and Desert: New Trends of the Camel Sciences

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Abstract. For a long time, camel sciences focused mainly on diseases and traditional use with some studies involved in physiological adaptation aspects. For the last decennia, new trends in camel and desert sciences could be observed. In analytical sciences, new data on blood and milk biochemistry, molecular genetic and immunology increased. Furthermore, new technologies in reproduction and in milk production processing were proposed through international cooperation between scientists, including high interaction with private sector. The adding values of camel products, especially milk, were studied in some cases. New techniques for intensification of camel farming were proposed and tested in farms, both for reproduction and production. In veterinary sciences, ecopathological approach was still rarely developed, except to study diarrhoea on young camel. Moreover, systemic studies, with the aim to consider camel into their ecosystem, were rarely engaged except for wild camel in Australia. Finally, economical studies of camel sub sector both at national level and in international trade is the main lack in camel sciences today. According to these trends, advances research in camel sciences could be supported by the international scientific community and funding agencies by promoting the role of camel and camel farming in desertification combat and food security in arid lands.

Introduction

According to the number of publications focused on camelids each year, we can consider that the interest of the international scientific community still exists. The trend is to a slight increasing of the scientific production since 25 years. However, the camel studies are still quantitatively marginal compared to other ruminant species. This marginality is linked first to the low camel stock (around 20 millions) compared to cattle for example (around 1300 millions heads), and to the limited geographical distribution of this species, the camel being associated specifically to desert or arid areas in the old world. Second, for funding agencies and main decision makers, camel is rarely considered as a productive animal, but rather as an animal from the past, just interesting to walk in the desert with the tourists. So, the scientific interest of camel appears to be low for many research institutes in the North and even in the southern countries. For example, in sub-Saharan African countries, development projects and research interest increased first for political reasons after different periods of rebellion of nomads traditionally camel keepers (Mali, Niger, Chad, Morocco…). But in the same time, camel farming has shown high ability to be adapted to intensification process for dairy and meat production. Elsewhere, the camel appeared as a very interesting biological model for scientists in different field. The international scientific community must be aware to these trends, and the camel scientists, especially in the southern countries, contribute to the promotion of new scientific approaches. A short analysis of these new trends in

camel sciences is presented below. However, the camel scientists have to stay modest. From 1779 up to 2003, no more than 8000 official publications are available in camel sciences field, which is more or less the total number of references for cattle into two years.

1. The Camel as a Biological Model

The adaptation of camel to desert conditions (water and food shortage, high temperature, low nutritive value of feeding resources) has fascinated many scientists in the past. The studies on the ability of camel to support dehydration, poor quality of the diet, specific deficiencies or hot climate are among the most common researches concerning that species. In the recent decennia, different studies have allowed advancing in the knowledge of the metabolism of the adaptation especially to dehydration, energetic deficiency, low protein diet, mineral deficiency. But the camel has been also an interesting biological model in immunology, pharmacology, nutrition and preventive medicine.

1.1. The Metabolism of the Adaptation

The adaptation is ability to survive and produce in unfavourable conditions. By this aspect, camel is a rare big size animal able to accept desert conditions. The adaptation to dehydration and rehydration is one of the better known mechanisms [57,55,9]. This adaptation is the result of remarkable anatomical and physiological peculiarities [19]. Two main mechanisms are playing: (i) the reduction of water loss by economical process (as the decrease of the urine excretion, decrease of the basal metabolism, body temperature variation) and sweating, and (ii) maintenance of homeostasis by the regulation of the vital parameter concentrations and by a maximal excretion of metabolic wastes.

Camel is well adapted to food shortage both from energy or nitrogen. This aspect as been well studied for several years and the ability of camel to valorise forages with poor nutritive values is quite established [32]. For a long time, the blood biochemistry references were reported on descriptive point of view only. The most of publications was focused on factors of variation as gender, age or season. The studies of the fine mechanisms by analyzing the dynamic of the blood parameters according to different type of feeding treatment were recent [17]. The requirements for the camel, both for energy and protein, are known since the use of respiratory chamber to measure the gas exchange [26,54]. The minerals in camel were also widely studied in the last decennia for a better understanding of the mineral metabolism. Hydro-mineral metabolism and its hormonal regulation were deeply studied recently with special attention to calcium and phosphorus metabolism [45,15]. New data on trace elements metabolism have allowed a better understanding of the camel adaptation to mineral deficiencies. Published results showed the diversity of the involved mechanisms: increasing of the absorption capacity in scarcity periods, higher storage capacity, tolerance for minerals in excess, maintenance of enzymatic activity in deficient period [18,21].

1.2. The Pharmacological Model

Most of the time, medicines were given to camel with similar doses than for cattle. However, recent trials have shown that the metabolism of medicinal molecules is slower and can not be compared to other ruminants in all the cases [41]. Moreover, the ability of camel to metabolize toxins seems less efficient than other ruminants. For example, aspirine esterase activity is lower than in goat, sheep or cattle. Also, cholinesterase which is the main detoxifying enzyme in mammals has a twice lower activity in camel compared to goat [3]. So, it

seems that camel has a lower ability to metabolize xenobiotics as medicines or toxins. More generally, the reaction speed of the camel to general metabolism appears to be slower in many cases. Veterinarians have to paid attention with the use of medicine in disease prevention or treatment of camels.

1.3. The Immunological Model

The immunological peculiarities of this species are going on to be well studied. The immunoglobulin molecule in mammals is composed of heavy and light chains. However, the camel antibody showed heavy chains only, which is unique in the mammals. This reveals high differences with other animals [6]. This recent biological discover has stimulate a high interest for scientists in the treatment of different diseases in human. Indeed the camel antibody has a quite simple structure which allows their use in vaccine biotechnology and cancer prevention. Probably, those results have effect also on diagnosis kit of some diseases, including human diseases. The defence reaction of the animal to pathogenic aggression and to disease can take specific form. The camel antibody is a true "*gold mine*" for the medical research on immunology [25].

1.4. The Particular Interest of Camel Milk

Traditionally, camel milk and products were appreciated for their medicinal properties, notably on infectious diseases as tuberculosis. Many papers, especially from Central Asia, were published [14] but poorly available in the international literature. However similar results were published in India [38] and Libya [4]. Milk and fermented milk are now analyzed by more precise methods and fine protein composition is now available, especially proteins with antibacterial effect as immunoglobulins, lysozymes and overall lactoferrine. The medical research is particularly interested by the high quantity of lactoferrine in camel milk and its use in biotechnology [34]. The stimulating medicinal activity of camel milk is associated also to vitamin C which is linked to the immune system. The factors of variability of the vitamin C (effect of age, gender, diet and season) are well-known in camel [16]. Some authors said that the health effects of camel milk are also available on nutritional and metabolic diseases as diabete. Camel milk has a hypoglycemiant effect and on glycaemia regulation in insulin dependant patient [2]. Further studies have to be extended to confirm the true effect of camel milk regularly drinking on health consumer [58].

So, through those examples, camel is continuing to raise up a high interest as biological model for the scientists in the world. The close adaptation of camel to harsh desert conditions seems to have selected a remarkable animal from physiological point of view. The knowledge of this physiology is far away to be ended. The main feature is that camel could show high interest for human medical research.

2. The Camel, from the Desert Ship to a Productive Animal

The general public is often surprised by the ability of the camel to produce milk, meat and wool and by the fact that consumers of those products still exist. It is obvious that the total camel milk or meat consumption is very marginal at the world level. The camel milk represents 2% of the world milk production and the camel meat, 1.1% only. However, its part is more important in desert countries: for camel milk for example, 7% in Mauritania, 9% in Saudi Arabia, 38% in Somalia, 39% in the Emirates. In fact, the camel has been able to enter in certain modernity and to integrate a productive dynamic for the satisfaction of a

more urbanised population from arid countries in milk and meat [22]. The camel and some camel producers have accepted the intensification of the production system.

2.1. New Features in Camel Milk Processing

The milk processing was one of the main constraints of the development of a convenient milk sub-sector. Traditionally, the cheese transformation is considered as difficult. So, the milk storage under cheese form is not common in traditional system. Second, the camel milk collection in extensive system characterised by the high mobility of the herds, is quite uneasy to organise. In Central Asia, the traditional fermented milk (*shubat, chal, agaran*) is often sold in Bazaar but without integration of the classical quality approach mostly required by modern factories and markets [35]. Nevertheless, recent advanced research was achieved to improve the camel cheese making [43] and specific rennet (*Camifloc N.D*) is available on international market. The organisation of the milk collection for modern dairy plants in pastoral zone has been proposed in different countries as in Saudi Arabia or in Mauritania [1]. Similar changes in traditional nomad society where camel milk is rather given than sold can be observed in Niger [53].

2.2. Intensification of Camel Production and Reproduction

The intensification of the camel production could be envisaged by:

- a better control of the reproduction to improve the fecundity and to decrease the calving interval
- a better survival ability of young camel to improve the numerical productivity
- a food supplementation to improve the growth of the young for a better meat productivity
- a milk valorisation and selection of the best productive camels

The workshop organised in Paris [47] has gathered information to improve the reproduction performances in camel. Some practices were tried notably in Tunisia, as the early separation of the young [40] associated with artificial milking [36] and the hormonal induction of sexual activity in female [37] to decrease the calving interval and improve numerical productivity. The food supplementation at key moment of the reproduction cycle contributes to an early return of the sexual activity [27].

The decreasing of the young mortality is one of the main ways to improve the numerical productivity. Health monitoring can have a strong effect to decrease diarrhoea which is the first cause of mortality in young animals [7]. The increasing of the young camel growth can be ensured by the food supplementation in order to improve the weight productivity which is very low in that species compared to other ruminants. An early fattening, especially of male, allows slaughtering the animals before the reproduction time that improve the organoleptic quality of the camel meat [33]. In female, a rapid growth contributes to the decreasing of the first calving age that increases the reproduction cycle.

The improvement of dairy productivity was achieved in some countries, notably in the Arabic peninsula, in Pakistan or in Turkmenistan. The intensification of the production could be attempted by food supplementation. In Africa, the productive camels are settled around the towns whilst the males and dried females moved in pastoral areas [20]. The periurban settlement is favourable to health control and to shorter market chain which facilitate camel milk valorisation on local market.

Another point involves the management of body condition score, which is a common practice to appreciate the requirements of the productive camel. The ability of camels to cope with food shortage is the result of a long evolutionary process in natural conditions

where food availability seasonally fluctuates. Lipid deposition and mobilisation is a part of the physiological strategy to anticipate the needs for pregnancy, lactation or food shortage [12]. In arid conditions, all the adaptive mechanisms and especially body fat mobilisation strategies are of considerable importance in determining reproductive performance [52]. A body condition score was proposed recently for the management in intensive conditions [23], as well as a new RIA tool to measure leptin in camel [13], a hormone secreted by adipose tissues, which could play a role in energy metabolism and reproduction.

Finally, it is clear that camel can be adapted to more intensive farming system and express its productive potential, both for meat and milk.

2.3. The Use of Biotechnology for Reproduction

The dairy intensification could be supported by a strict control of the reproduction: the practices for reproduction cycle acceleration, the improvement of the genetic potential contribute to the increasing of milk production all along the life. The use of artificial insemination and embryo transfer is the main modern techniques for the control of reproduction and for the management of the genetic selection. Those techniques were set up in camel recently [49]. They are not very common among camel producers and their efficiency is still weak without a strong material support and human competences. For the moment the extension of those biotechnologies is limited, and further physiological researches are necessary. However, significant advances in the achievement of those techniques were got, especially in the particular context of racing camels in Arab Emirates. For example, it has been possible to get twins by embryo splitting [52] or to get hybrid between camel and lama [50].

2.4. Farm Management for Champions: The Racing Camels

The racing camel is very popular in Arabic countries, especially in Emirates, Qatar, Saudi Arabia, Kuwait and Oman. In countries where four-wheel drives are predominant, the camel races are the mean to keep the Bedouin tradition. But, as few data were available on the physiological answer to intensive exercise, most of the involved countries have developed well equipped research laboratories and institutes. Some physiological aspects of racing camel are fully studied [48]. A sportive animal needs a special diet similar to champion. He has to achieve an intense effort including endurance and speed. So the racing camel needs fast fermentable energy, high quality proteins, minerals and vitamins. The energy has to be given by carbohydrates in short effort (dates, honey) and lipids for long effort. Proteins have to be rich in sulphur elements and not in big quantity (cow milk, butter, eggs). Calcium and phosphorus to get a strong skeleton, trace elements for cellular metabolism, vitamin C and other vitamins for their anti-stress activities have to be an essential part of the diet. The basal diet includes generally good quality forages as alfalfa, maize, barley or sorghum. The specificity of such diet allows exploring more in details the camel feeding in extreme conditions.

2.5. The Disease Control: Ecopathology and Disease Surveillance

The main constraints to organise efficient camel health control procedures could be summarized as follows [24]:

– Camel is living in harsh conditions, mostly with mobile farmers. This mobility can lead camel herds to cross borders, then the disease control has to be regional,

- Camel is living in marginal desert areas where the density of veterinary facilities (veterinary clinics and animal health posts, slaughter houses, vaccination crushes, veterinary drugstores and so on) is very low,
- Camel is rarely affected by infectious disease outbreak [56] and the absence of systematic vaccination which gives difficulties for national veterinary services to reach regularly the camel herds and to collect available epidemiological data,
- The specific know-how of veterinary services on camel diseases is low because the training of veterinarians in most of the veterinary faculties from involved areas by camel rearing is rarely sufficient in term of camel sciences knowledge. Moreover, the know-how is very low also among the technicians from livestock services.

Elsewhere, the camel farming is submitted to new trends as settlement and intensification, the necessity to give security to pastoral systems and the introduction of camel production into market. Such trends lead to the raising up of multifactorial diseases, and allow setting up camel disease control network more reliable, particularly between the Horn of Africa and the WANA where the main flow of camel through exportation market occurs.

However, a camel disease control is proposed by OIE (*Office International des Epizooties*). The disease control procedures for camel can be similar than for other species, but it must be adapted to the conditions detailed above. For example, the procedures used in the frame of PACE programme in the Horn of Africa include (i) the establishment of a technical team for collecting data (slaughterhouses, market, disease declaration or disease reporting in veterinary clinic), data treatment and edition of an epidemiological bulletin, (ii) the training of livestock technical officers or technicians in local veterinary services on camel diseases (diagnosis and treatment), (iii) the training and support of animal health operators which are camel farmers susceptible to distribute some basic treatments and drugs, (iv) regular meetings with camel farmers for information on general hygiene and good farming practices.

A specific aspect concerns the multifactorial diseases as mastitis, reproductive failures, metabolic disorders, diarrhoea in young animals and so on. The only analytical approach for these diseases is not sufficient. For example, the study of young camel diarrhoea was mainly focused on microbiological aspects [11,7]. Recent analysis of the risk factors linked to environmental conditions and farming practices were performed [8]. Those studies could be more operational for camel producers.

So, the camel is engaging in the modern productive revolution. It has shown that it's not the animal of the past. It can enter in the modernity, to be adapted to intensification process and answer to the international animal products market. But the training institutions and research institutes have to deepen their knowledge for a better insertion of camel farming in this dynamic and support camel producers in these main changes.

3. The Camel, a Main Element of the Desert Ecosystem

The desert science, named "eremology" [39], has highly changed with the international concern on desertification process through the world. Arid areas involved 35% of the emerged lands on the earth. Today, many scientists pay attention to the desert as a complex ecosystem. The desert includes two types of resources (poor resources but perennial and abundant resources in case of rain, but episodic), so the strategies of desert animal fall into this ambivalent situation. The flexibility and the elasticity are the main animal behaviour to adapt in desert conditions. However, most of the researches were interested by physiological adaptation as described above rather than to the place of camel in the desert ecosystem.

3.1. The Camel, an Element of Desertification Combat

The camel, by these physiological, anatomical and behavioural particularities can contribute to the desertification combat [51]. First, its feeding behaviour [30] contribute to a rational use of the natural resource. On average, the camel has a basal diet richer in forage-trees and the variability of grass eaten is widely higher than for other ruminants [46]. The soft anatomy of its feet [5] is less aggressive for the soil compared to cattle. Its ability to valorise poor forages and its drinking rhythm which could be once a week, allow a wide exploration zone to find food [19]. So, the overgrazing is rarely observed with camel in traditional farming system. In the recent draught in the Horn of Africa, it has been observed that farmers having changed their camel flock to cattle flock have shown a lower resistance to the crisis. Most of the bovines died but camels survived, continuing to give their products to the farmers in spite of the food shortage [10].

3.2. The Desert Productivity: The Added Value of the Camel

Second, camel is able to give back production from the desert ecosystem. The evaluation of the desert productivity through the camel production is an important point of view. Some current studies are achieved for example to evaluate the milk productivity of milk basin around Agadez in Niger. In fact, very few studies were achieved in that way. Recently, in the Sahelian countries, it has been observed a diversification of the camel using: after packing, milking and fattening, the use of camel for ploughing, which is already popular in India and Pakistan [44], and overall for agricultural activities (ploughing, harrowing, seeding), becomes very common [42]. The extent of drought in such countries has contributed to the widening of the occupation area by camel farms [19]. This shows the role of camel in the ability to maintain rural activities in scarce ecosystem and to increase, not only the animal productivity of the desert, but also the agricultural activities of the desert margin.

3.3. The Desert Valorisation: The Added Value of the Camel Producers

The camel is the one of domestic species which allows the maintenance of human life in desert conditions. Camel is strongly contributed to the balance between the milieu (the desert or arid lands), the available resources (poor but usable for camel production) and the human economy and wellbeing. It is one essential element of the pastoral ecology. In some countries, it is an element of tourist attraction and desert discover. Its products, widely appreciated for human consumption, can be commercially promoted. The “multi-purpose” camel [28] is a guarantee for a non-industrial valorisation of the desert. In some cases, the valorisation of camel products on the local or regional market is linked to the desert picture, as the cheese “caravane” promoted by the dairy plant in Mauritania. Very specific products as the fermented milk in Central Asia (*Shubat, Chal* and others) could be proposed on international market for their nutritional adding values. Anyway, this international valorisation needs at first recognition by the *codex alimentarius* which does not include camel milk in its list up to now. For that purpose, further researches on the characterisation of the milk products and production mode of camel milk are necessary.

Conclusion

This rapid flight over of the current trends of research on camel as a biological model, as a productive animal for food supply in desert area, or as an element of the desert ecosystem shows that the camel in the desert and submitted to the desert conditions can contribute to

the desertification combat and to the food security. The camel scientists have to convince the funding agencies of the high interest of the camel rearing and of the camel sciences for the promotion of the desert productivity and preservation. However, some lack in camel researches can be considered. Very few data for example are available on camel genetic, especially on camel selection except probably in the New Independent States from Central Asia. But even in that case, the scientific literature is poorly available for the international scientific community because mainly published in Russian language. Another field which is poorly documented is the camel farming economy or the economical analysis of camel sector in the livestock production. Some recent "grey literature" published by ACSAD are available [31,29] but limited to Pakistan and Sudan respectively.

The necessity of an International Association for Camel Sciences will be obviously a strong manner to stimulate coordination research between the different camel sciences network through the world.

References

[1] **Abeiderrahmane N.,** 1997. Camel milk and modern industry. J. Camel Pract. Res., 4, 223-228.

[2] **Agarwal R.P., Swami S.C., Beniwal R., Kochar D.K., Sahani M.S., Tuteja F.C., Ghouri S.K.,** 2003. Effect of camel milk on glycemic control, risk factors and diabetes quality of life in type-1 diabetes: a randomised prospective controlled study. J. Camel Res. Pract., 10, 45-50.

[3] **Al-Qarawi A.A., Ali B.H.,** 2003. Variations in the normal activity of esterases in plasma and liver of camels, cattle, sheep and goats. J. Vet. Med., A50, 201-203.

[4] **Alwan A.A., Tarhuni A.H.,** 2000. The effect of camel milk on mycobacterium tuberculosis in man. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100.

[5] **Arnautovic I.,** 1997. A contribution to the study of some structures and organs of camel *(Camelus dromedarius).* J. Camel Pract. Res., 4(2), 287-293.

[6] **Atarouch T., Bendahman N., Hamers-Casterman C., Hamers R., Muyldermans S.,** 1997. cDNA sequence coding for the constant region of the dromedary (3 heavy chain antibody; J. Camel Pract. Res., 4, 177-182.

[7] **Bengoumi M., Berrada J., Rochdi M., Hidane K., De La Farge F., Faye B.,** 1998a. Physiopathologie des diarrhées du chamelon au Maroc. Signes cliniques et perturbations métaboliques. Rev. Elev. Med. Vét. Pays Trop., 51, 277-281.

[8] **Bengoumi M., Michel J.F., Hidane K., Bonnet P., Faye B.,** 1998b. Ecopathological study of the camel young mortality in the south of Morocco. Proc. 3rd ann. meeting for Anim. Prod. under arid conditions. Al-Ain, May 2-3, U.A.E.

[9] **Bengoumi M., Faye B.,** 2002. Adaptation du dromadaire à la déshydratation. Revue Sécheresse,13, 121-129.

[10] **Bonnet P., Faye B.,** 2000. Enjeux zootechniques de la famine en Ogaden. Les Nouvelles d'Addis n°18. Août 2000, p.15.

[11] **Boubaker A.,** 1995. Contribution à l'étude des agents infectieux et parasitaires des diarrhées du chamelon au Niger. Thèse de doctorat en médecine vétérinaire, Ecole Nationale de Médecine Vétérinaire de Sidi Thabet, Tunisie.

[12] **Chilliard Y.,** 1989. Particularités du métabolisme des lipides et du métabolisme énergétique chez le dromadaire. Options méditerranéennes. "Digestion, Nutrition et Alimentation du dromadaire". Série séminaires, 2, 101-110.

[13] **Delavaud C., Bengoumi M., Faye B., Tabarani A., Faulconnier Y, Sghiri A., Chilliard Y.,** 2004b. Plasma leptin measurement in the dromedary camel and its relationships to adiposity and feeding level. International Conference on Farm Animal Endocrinology, Budapest, Hungary, 4-6 July, 2004, in press.

[14] **Djangabilov., A.K., Bekishewa A.C., Mamirova T.N.,** 2000. Medicinal properties of camel milk and Shubat. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100-101.

[15] **El Khasmi M., Riad F., Safwate A., Hidane K., Faye B., Davicco M.J., Coxam V., Barlet J.P.,** 2001. Postpartum evolution of mammary secretion of minerals and 25-hydroxyvitamin D in lactating camels (Camelus dromedarius). J. Camel Pract. Res, 8(2), 131-135.

[16] **Elkhidir H.E.,** 2002. Vitamine C status in Sudanese camels. Utrecht Univ. Thesis, 89 p.

[17] **Faye B., Saint-Martin G., Cherrier R., Ali Ruffa,** 1992a. *The influence of high dietary protein, energy and mineral intake on deficient young camel: I. Changes in metabolic profiles and growth performance*. Comp. Bioch. Physiol., 102A, 409-416.
[18] **Faye B., Bengoumi M.,** 1994. *Trace-elements status in camels: a review*. Biol. Trace Element Res., 41, 1-11.
[19] **Faye B.,** 1997. Le guide de l'élevage du dromadaire. Ed. Sanofi. Libourne (France), 118 pp.
[20] **Faye B., Bengoumi M. Hidane K.,** 1998. Le développement de l'élevage laitier péri-urbain : l'exemple de Laâyoune (provinces sahariennes du Maroc). Actes de l'atelier international : « Marchés urbains et développement laitier en Afrique sub-saharienne », Ed. G. Duteurtre et C. Meyer, 9-10 sept., Publ. CIRAD, Montpellier, France, 103-108.
[21] **Faye B., Bengoumi M.,** 2000. Le dromadaire face à la sous-nutrition minérale : un aspect méconnu de son adaptabilité aux conditions désertiques. Revue Sécheresse, 11(3),155-161.
[22] **Faye B., Grech S., Korchani T.,** 2002a. Le dromadaire, entre féralisation et intensification. *In:* Domestications animales : dimensions sociales et symboliques. VII^{éme} coll. Int. HASRI. Villeurbanne, 21-23 nov. 2002.
[23] **Faye B., Bengoumi M., Messad S., Chilliard Y.,** 2002b. Estimation des réserves corporelles chez le dromadaire. Rev. Elev. Med. Vét. Pays Trop., 55, 69-78.
[24] **Faye B.,** 2003. Surveillance and control procedures for camel diseases. Workshop on the surveillance and Control of camels and wildlife diseases in the Middle East. Regional workshop OIE, Sanaa (Yemen) 10-12 march 2003.
[25] **Gross M.,** 2000. Les chameaux donnent leur anticorps à la science. Revue La Recherche, 337, 30-32.
[26] **Guerouali A.,** 1991. Détermination des besoins nutritionnels du dromadaire pour l'entretien, la croissance, la gestation et la lactation. *In:* Etudes et Recherches appliquées sur l'élevage camelin. Rapport de synthèse. Publ. GERDEC, Rabat, Maroc, 49-56.
[27] **Hammadi M., Khorchani T., Khaldi G., Abdouli H., Slimane N.,** 1997. Effets d'une supplémentation par un aliment concentré sur les performances de production et de reproduction en période *post-partum* chez la chamelle (*Camelus dromedarius*) suitée et élevée sur un parcours du Sud-Tunisien. Actes du séminaire international « Acquis scientifiques et perspectives pour un développement durable des zones arides ». Djerba, 5-7 dec. 1996, 377-385.
[28] **Hjört af Ornäs A. and M. Ali Hussein,** 1993. Camel herd dynamics in southern Somalia: long term development and milk production implications. *In:* A. Hjort af Ornäs (Ed.),The multi-purpose camel: interdisciplinary studies on pastoral production in Somalia., EPOS, Uppsala Universidy, Sweden, 31-42.
[29] **Idriss B.,** 2003. Marketing of camels in the Sudan. ACSAD Publ., Dr Wardeh (Ed.), Damascus (Syria), 34 p.
[30] **Iqbal A., Khan B.B.,** 2001. Feeding behaviour of camel. Review. Pak. J. Agri. Sci., 38, 3-4.
[31] **Isani G.B.,** 2003. Aspects of camel marketing in Pakistan. ACSAD Publ., Dr Wardeh (Ed.), Damascus (Syria), 56 p.
[32] **Jouany J.P.,** 2000. La digestion chez les camélidés : comparaison avec les ruminants. INRA Prod. Anim., 13, 165-176.
[33] **Kamoun M.,** 1990. Dromadaire et intensification. Actes de la 41ème réunion annuelle de la Fédération Européenne de Zootechnie, Toulouse, France, 5-16.
[34] **Konuspayeva G.,** 2003. La lactoferrine dans le lait de chamelle. Essai de séparation par chromatographie sur colonne. Mémoire DEA, Université de Montpellier (France), 31 p.
[35] **Konuspayeva G., Faye B., Serikbaeva A.,** 2003. Les produits laitiers traditionnels à base de lait de chamelle en Asie Centrale. Atelier Int. sur le lait de chamelle en Afrique. FAO-CIRAD-KARKARA, Niamey (Niger), 5-8/11/03.
[36] **Khorchani T., Hammadi M, Moslah M.,** 1991. Résultats des recherches obtenus à l'Institut des régions arides de Médenine dans le domaine de l'amélioration de la productivité des dromadaires. Séminaire national sur l'élevage camelin. Douz, Tunisie, 29-30 déc. 1991.
[37] **Khorchani T., Ismaïl M., Hammadi M., Moslah M., Chammem M.,** 1997. Sauvegarde du dromadaire et amélioration de sa productivité : bilan des principales recherches menées à l'Institut des Régions Arides de Médenine (Tunisie). Actes du séminaire international « Acquis scientifiques et perspectives pour un développement durable des zones arides ». Djerba, 5-7 déc., 368-376.
[38] **Mal G., Suchitra Sena D., Jain V.K., Singhvi N.M., Sahani M.S.,** 2000. Role of camel milk as an adjuvant nutritional supplement in tuberculosis patients. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 99.
[39] **Monod T.,** 1992. Du désert. Revue Sécheresse, 1(3), 7-24.
[40] **Moslah M.,** 1993. L'amélioration de la productivité des dromadaires en Tunisie par séparation précoce du chamelon et allaitement artificiel. *In:* Atelier « Peut-on améliorer les performances de reproduction des dromadaires ? », Paris, 10-12 sept. 1990, Ed. CIRAD-EMVT, Montpellier, 225-238.
[41] **Oukessou M., Berrag B., Alvinerie M.,** 1999. A comparative kinetic study of ivermectin and moxidectin in lactating camels (*Camelus dromedarius*). Vet. Parasit., 83, 151-159.

[42] **Pacholek X.,Vias G., Faye B., Faugère O.,** 2000. Elevage camelin au Niger: référentiel zootechnique et sanitaire. Publ. Coopération Française, Niamey, Niger. 93 p.
[43] **Ramet J.P.,** 1993. La technologie des fromages au lait de dromadaire. Etude FAO Production et Santé Animales, Publ. FAO, Rome, 116 p.
[44] **Rathore G.S.,** 1986. Camels and their management. ICAR publ., New Dehli, 228 p.
[45] **Riad F., Bengoumi M., Safwate A., Giry J., Davicco M.J., Barlet J.P.,** 1994, Influence of the hydroxycholecalciferol on calcium and phosphorus concentration in camel milk. J. Dairy Sci., 61, 567-571.
[46] **Rutagwenda, T., Lechner-Doll, M., Schwartz, H.J., Schultka, W. & Von Engelhardt, W.**, 1990. Dietary preference and degrability of forage on a semi-arid thorn bush savannah indigenous ruminants, camels and donkeys. *Anim. Feed Sci. Techn.,* **35**: 179-192.
[47] **Saint-Martin G. (Ed.),** 1990. Peut-on améliorer les performances de reproduction des camélins ? Actes de l'atelier, Paris, 10-12 sept. 1990, Publ. CIRAD-IEMVT, Coll. Etudes et synthèses, 437 p.
[48] **Saltin B., Rose, R.J. (Eds),** 1994. The racing camel. Physiology, metabolic functions and adaptations. Special issue of Acta Physiol. Scand. (Suppl. 617), 95 p.
[49] **Skidmore J.A, Billah M., Allen W.R.,** 2000a. Using modern reproductive technologies such as embryo transfer and artificial insemination to improve the reproductive potential of dromedary camels. Rev. Elev. Méd. Vét. Pays trop., 53, 97-100.
[50] **Skidmore J.A, Billah M., Allen W.R., Short R.V.,** 2000b. Using modern reproductive methods to hybridize old and new world camelids: *Camelus dromedaries x lama guanicoe*. Rev. Elev. Méd. Vét. Pays trop., 53, 93-96.
[51] **Stiles N.,** 1988. Le dromadaire contre l'avancée du désert. La recherche n°201, 948-952
[52] **Tibary A., Anouassi A.,** 1997. Theriogenology in camelidae. Anatomy, physiology, pathology and artificial breeding. Actes Editions Publ., Rabat, Maroc, 489 p.
[53] **Vias G., Bonfoh B., Garba M., Ilou I., Kamil H., Faye B.,** 2003. Valorisation du lait de chamelle au Sahel : opération " fromages camélins " dans le Tadsit (Niger) et à Tombouctou (Mali). Atelier Int. sur le lait de chamelle en Afrique. FAO-CIRAD-KARKARA, Niamey (Niger), 5-8/11/03.
[54] **Wardeh M.,** 1997. The nutrient requirements of the dromedary camels**.** The camel Applied Research and Development Network. ACSAD/CARDN Publ. Damas, Syria, 97 p.
[55] **Wilson R. T.,** 1989. Ecophysiology of the camelidae and desert ruminants. *Springer Verlag, Berlin*.
[56] **Wernery U., Kaaden O.R.,** 2002. Infectious diseases in camelids. Blackwell Science Publ., Berlin, 404 p.
[57] **Yagil R., Sod-Moriah U. A. and Meyerstein N.,** 1974. Dehydration and camel blood. III. Osmotic fragility, specific gravity and osmolarity. *Am. J. Physiol.*, 226, 305-308.
[58] **Yagil R., Van Creveld C.,** 2000. Medicinal use of camel milk –fact or fancy ? Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100.

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Desertification in the Central Asian Countries

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Abstract. The present paper describes the reasons and consequences of the desertification process in the different republics from Central Asia after the collapse of Soviet Union. The diagnosis of the situation is quite worrying both for environment and for human population and their economic activities including livestock.

On the Eurasian continent Central Asia is perceived as a territory of five former Central Asian republics of the Soviet Union: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Their total area is equal to 3575.3 mln sq. km. The population is 54.43 millions. According to available forecasts, by 2025 the population of the Central Asian Region will grow to 65 – 75 millions.

Much of the territory of the Central Asian countries lies in the arid, semiarid and dry subhumid climatic zones and is represented by large deserts Karakum and Kyzylkum and also lands that are vulnerable to different extent to a man-made impact, which leads to intensive development of desertification processes under the mentioned climatic conditions.

Concentration of energy and material potential on compact territories results in formation of conflict environmental stress where desertification plays the leading role.

As is known, the UN Convention on Combat Desertification and Draught Control defines desertification as land degradation in arid, semiarid and dry subhumid regions as a result of the action of various factors, including climate changes and man's activities.

Physiographically, all arid and semiarid regions in the world display close features and, thus, they are similar in many respects. However, they differ by the practiced economic activities that determine loads on the natural environment. Among obvious kinds of activities matching the existing soil-climatic conditions of the Central Asian region are pasture (distant-range grazing) animal husbandry and irrigated farming, oil, gas and mining industries. Concrete economic activities and their structure in some arid and semiarid regions change visibly depending on the country in which these regions locate and how they are integrated into the domestic labor division system. It is these activities, that, in combination with regional specifics due to climatic, hydrogeological, agroclimatic, soil and landscape conditions, inhomogeneity of biocomplexes and different levels of socio-economic development, determine the character and intensity of desertification processes.

Among the key factors leading, finally, to desertification, with regard to specific features inherent to the Central Asian region, are the following:

- Grazing or pastoral desertification – overgrazing leading to pasture degradation, pasture digression, deterioration of the pasture vegetation;
- rainfed desertification, unjustified cultivation of light and heavy soils and their subsequent wind and water erosion, development of dust storms, growing areas of drifting sands, dehumification;

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- reclamation desertification manifested by wide-scale secondary salinization and alkalinization, flooding and submergence of lands as a result of seepage water losses, water erosion due to irrigation;
- "marine desertification" in the Caspian Sea zone – due to its water level dynamics and wave surge events;
- cutout and inhibition of wind-shield and water-protecting tree and shrub vegetation for fuel and forage for cattle;
- "migration desertification" caused by migration of the population from the Circum-Aral areas to, in particular, Southern Kazakhstan and, as a result, the increased load on the natural environment in living areas;
- man-made desertification developed as a result of military tests (Azgir, Taisoigan, Betpakdala) that result in radiation contamination of vast territories, their pollution with very hazardous components of missile fuel, metal constructions of missiles, etc., functioning of the Baikonur cosmodrome, movement of heavy transport means, carrying out of drilling and earth-moving works, road, industrial and civil construction, development of mineral deposits;
- chemical desertification caused by industrial pollution;
- radioactive desertification (Semipalatinsk nuclear test grounds, Azgir and others).

It should be noted that in the period of formation of the New Independent States in the absence of regulatory-legal nature-conservation acts the problem of desertification in some regions became abated, on the one hand, and, on the other, acquired a steady tendency to intensification and expansion. Abating was caused by drastic reduction of loads on pastures due to shrinkage of cattle population which at that time acquired the status of "money relations". As concerns irrigated farming – due to reduction of irrigated areas and also pollution caused by application of fertilizers, pesticides and herbicides. As an example we can take Turkmenistan where in the recent seven years (1995 to 2001) the application of pesticides, herbicides and defoliants became 2.9-fold less, while the area of lands where they were applied was decreased 4-fold. On the contrary, intensification was caused by growing cutting of forests for commercial purposes, in irrigated farming – by lack of finance for maintenance and operation of drainage networks and, in general, because of the economic crisis.

Now let's have a brief overview of desertification development in some states of Central Asia.

1. Kazakhstan has at its disposal vast land resources. Out of 272.5 mln ha of the Republic's territory 222 mln ha are agricultural lands. The traditional system of land use and animal husbandry based on nomadic seasonal use of pastures was the most rational and sparing system. From the mid-XIXth century due to soaring development of mining and processing industries and especially due to agricultural development of virgin lands, a considerable man-made pressing on the natural systems in Kazakhstan began. Cultivation in 1954–1960 of more than 20 mln ha of virgin and fallow lands led to deterioration of soil physical properties, 20–30% loss of humus, growth of areas prone to wind and water erosion. The most vulnerable is the vegetation cover in the desert and semidesert zone that extends over 50% or 128 mln ha of the Republic's territory. Intensive non-systemic utilization of pasturelands led to a drop of their yielding capacity, deterioration of the composition of grass varieties, to desertification of nearly 30% of the whole grazing territory. Desertification of pastures in some regions becomes irreversible. This is true of major sand areas, such as Volga-Ural sands, Kyzylkum, Circum-Caspian Kyzylkum. In general, in the Republic 66% of lands or 180 mln ha are affected by desertification. Considerable areas of irrigated lands are subject to secondary salinization, especially in the Syrdarya delta, where practically all soils are saline. Rainfed lands are also affected by salinization.

2. Tadjikistan. Desertification here is associated here, first of all, with erosion processes. Arable lands have a thin soil cover and are characterized by considerable sloping of the relief. Out of the total area of agricultural lands making 9,500 thou ha, approximately 3,000 thou ha are affected by water erosion, 600 thou ha – wind erosion, approximately 700 thou ha – mixed-type erosion and 300 thou ha – irrigation erosion. And about 400 thou ha are potentially vulnerable lands. The key factor of land desertification in an irrigated zone is secondary salinization. In general in the Republic the area of heavily saline lands makes 7,000 ha, slightly and medium saline – 100,000 ha. Intensive cattle grazing leads to degradation of pastures and haylands. In southern desert and semidesert regions, the pasture productivity dropped sharply. Rather widely developed is man-made desertification, which is connected with intensive development of mineral resources. This refers, first of all, to deposits of building materials the area of which exceeds 2,500 ha. Places of their development are seatbeds of wind erosion and drifting sands.

3. Uzbekistan. Man-made desertification affects 59.2% of the Republic's territory. The problem of desertification, or, more exactly, land degradation in the country is connected with consequences of mono-crop growing – cotton under irrigation that began still under the Tzar regime and reached its maximum in the Soviet period. As a result of inordinate growth of irrigated lands with inefficient utilization of water resources and poor drainage, excessive application of fertilizers (1.5 mln tons a year, 350–400 kg/ha), various herbicides (85–90 thou tons a year, 50–54 kg/ha), of which 50% are defoliants, the situation here became critical in socio-environmental terms. Out of 4,300 thou ha of irrigated arable lands in Uzbekistan more than 2,500 thou ha or 60% are affected by salinization to various degree, in particular, in the middle and lower reaches of the Amudarya and other rivers. All soils in the Republic are polluted with considerable quantities of DDT and HCCH. The existing structure of cultivated agricultural crops led to development of water erosion and soil deflation. The latter affects approximately 73% of all agricultural lands, including 56% of irrigated lands. The situation is most grave in the Western and Central Ferghana, Southeastern Golodnaya and Karshi Steppes, in the Bukhara oasis. Irrigation erosion is developed on 18% of all agricultural lands.

4. Turkmenistan is a country of deserts. Here deserts themselves become a source of desertification. Desertification, that affects 66% of the country's territory, is the most burning environmental issue in the Republic. And without solution of this problem one cannot speak about sustainable development here. Desertification reveals itself mainly in degradation of the vegetation cover, wind and irrigation erosion, secondary salinization and overwetting, eolian relief formation and technogenic loads. On the territory of the country 68% of irrigated lands, taking approximately 3.5% in the total land stock, are prone to medium and heavily salinization. About 36% of these lands locate in the areas with high groundwater occurrence (up to 2 m from the ground surface), thus, they are affected by secondary salinization and overwetting. The salinity problem is acute for the irrigated zone extending along the Karakum River and for the Turkmen part of the Circum-Aral territory. Out of the total territory of the country 20% of lands locate in areas with erosionally hazardous mountain and piedmont landscapes affected by deflation, 80% - with desert landscapes and also affected by deflation.

5. Kyrgyzstan. The territory of this country is covered largerly by mountains – approximately 94% of its territory has altitudes more than 1,000 m MSL and 40% - over 3,000 m. Nearly the whole territory is confined to the Tien-Shan Mountains. Among the main orographic features there are Issyk-Kul Depression, Talass Valley, margins of the Ferghana Valley. The area of arid and dry lands here amounts to 14.5 mln ha. Out of the total agricultural area equaling 10.1 mln ha only 1.34 mln ha are cultivated, 80% of them are under irrigation. Desertification in the country is represented, largely, by erosion proc-

esses that, together with mountain slopes, cover an area of 550 thou ha. In addition, approximately 60,000 ha of irrigated lands are medium and heavily saline. Here we may add about 64 thou ha of slightly saline lands that may turn into medium and heavily saline due to the absence of adequate drainage. As a result of degradation of piedmont and mountain pastures their productivity has become 25 to 30% less. A forest coverage of mountains in Kyrgyzstan had dropped from 7.2% in 1930 to 4.2% at present. Around settlements forests and shrubs are cut out completely.

Special mention deserves desertification in mountain regions of Uzbekistan and Tadjikistan that, strictly speaking, cannot be fully referred to arid areas. At the same time, desertification sources are found here. They are settlements, mining areas, spring-summer pastures, recreation objects and others. This is most vividly seen in mountain spurs surrounded by densely populated valleys. Forest coverage of mountains in Uzbekistan (by estimates of different literary sources) makes 2 to 3%. Shrinkage of forested areas is connected with more intensive forest cutting for commercial purposes and for fuel, which is a result, in particular, of stopping of coal supply from Russia and Kazakhstan.

Because of non-systemic grazing of cattle, the washout of soils has intensified significantly reaching on the grazing slopes 20 to 25 t/ha. In Uzbekistan and Tadjikistan the washed-out and scoured mountain slopes make more than 80%.

Considering the general situation with desertification in the Central Asian countries, it is impossible to neglect the so-called “Hot Spots”. Such regions in Central Asia are Circum-Aral territory, Semipalatinsk nuclear testing grounds, Circum-Caspian region (Atyrau and Aktau regions in Kazakhstan).

The **Aral** tragedy is known all over the world. This is not only an environmental catastrophe, but, first of all, the catastrophe of the local population that earlier lived on the seashore and now on the “shores” of the forming man-made desert Aralkum.

By the end of 2002 the Aral Sea level dropped by 23 m and not it is 30.47 m. The water area of the sea has shrunk from 66 thou to 15 thou sq. km, while the volume – from 160 to approximately 100 cu. Km. As a result of the sea recession there are exposed 25 thou sq. km of the sandy-solonchak surface. Creeping desertification affected over 4.5 mln ha having turned former pasturelands into a desert, which caused serious damage to cattle breeding. The groundwater level over the whole Circum-Aral area has lowered; this led to changes in the plant nutrition regime and soil-formation processes. In the Turkmen and Uzbek parts of the Circum-Aral area up to 90–95% of irrigated lands are affected by salinization. The dried bottom of the Aral Sea has become a seat where heavy dust-salt storms originate. Dust is carried to a distance of 150–500 km. Only from the southeastern coast of the Aral Sea 15 to 75 mln tons of dust rise every year. This process leads to the so-called “aerial” desertification manifested in slowly accumulating changes in soil conditions and vegetation – salinization and inhibition of the latter.

We have already mentioned a specific region of radiation desertification – **Semipalatinsk nuclear testing grounds**. For four decades of its existence there were conducted 470 explosions here: 90 air-born, 26 on-land and 354 underground. These tests led to breaking of natural processes and links among structural elements of ecosystems, man-made natural complexes, disturbances of ecological equilibrium and, in general, to damage to the biotic component of ecosystems.

Acuteness of environmental issues of the **Circum-Caspian territories** and, in particular, desertification, may be attributed to periodically varying sea level.

On the territories of old oil oilfields in the Atyrau and Mangistau Regions, where oil extraction began in the mid-XXth century, soils are soaked with oil to a depth of 10 m, about 800 ha are permeated with fuel oil and approximately 200 thou tons of oil are still stored in pits of old oilfields. And this problem is included into the State Program of the Kazakh Caspian Sector Development Till Late 2005.

And here application of inadequate constructions and equipment in production and transport, lack of systems for prevention of losses and accidents and others aggravate still more the pollution degree of the oil complex. Quite recently, there was made public the following data – for the whole period of oil extraction in Western Kazakhstan 6 mln tons of oil were lost to spills.

Beginning from 1978 the Caspian had been in a transgression stage. The sea level rise by more than 2.5 m led to inundation of the shore at a rate of 1 to 2 km a year, wave surge events with the surge wave up to 2-3 m high moving inside a coastal area to 20 km, erosion intensification, breaking of embankments, shore abrasion at a rate up to 10 m a year, an overall rise of ground waters and waterlogging of lands.

The rise of the Caspian Sea level incurred considerable damage to the economics as this resulted in drastic changes of the engineering-geological, soil-reclamation, hydrodynamic and hydrometeorological conditions in the coastal zone.

Submergence of vast territories is witnessed every year in autumn and spring in the periods of storm winds (for instance, in April 2000) that force seawaters rolling over the coast and, thus, inundate oilfields. Therefore, huge territories of coastal lands, especially in the northeast, are completely permeated with oil brought with seawaters. Dozens of kilometers of oil pipelines, power transmission lines, settlements, evaporation grounds are subject to inundation during such surge events.

The abandoned "no-one" oil wells in Kazakhstan and especially in the zone flooded by the Caspian Sea present a serious problem. On the territory of the Atyrau Region there are approximately 1.5 thousands of such wells, of which 142 are under water. From time to time oil is flowing out from the latter. Such wells are found in oilfields Pustynnoye, Tadjigali and Pribrezhnoye.

As a result, in the areas of oilfields and oil pipelines the zones of overall *technogenic and chemical desertification* are formed where up to 80% of the vegetation cover are destroyed.

The negative impact of such zones on the natural environment is always of a long-time nature, which results in depletion and extinction of various fauna species. The formation water that is extracted together with oil is disposed without any treatment to "evaporation grounds"; the volume of such water in the region amounts to 1 bill cu. m. Such formation water induces radioactive contamination, and level of thorium and radium in it reaches 17,000 μR/hour.

In the past decades, the issue of global warming is more and more often brought to the fore. It is especially topical of the Central Asian countries suffering most acutely from desertification and draughts, because it can spur the processes of environment degradation, aggravate social and economic consequences. For the recent four decades, the glaciation area in the mountains of Central Asia shrank by nearly 40%, which results in depletion of flows of such big rivers ad Amudarya and Syrdarya. Severe draughts of 2000–2001 in Uzbekistan, Turkmenistan and Southern Kazakhstan intensified desertification processes as a result of noticeable changes of some climatic elements in all seasons of a year. In this context, the issues of desertification combat acquire special importance in all countries of Central Asia.

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Camels of the Arvana Breed: History, Modern State and Perspectives for the Development

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Abstract. In Turkmenistan, dromedaries of the Arvana breed created as a result of long selection. The pasture conditions in Karakoum desert which occupy area more than 38 mln ha make possible to maintain significant herd of camels. They using to the fodder an upper part of the suffrutescent bushes and do not limit the possibility of the growth of sheep and goats livestock. Camels do not disrupt the ecology of deserts, as showed the special studies by -Research Institute of Livestock and Veterinary Science. Because of the extreme insufficiency of irrigation water in the territory of Turkmenistan for many years the basic form of animals remained sheep and the camels, their number in the former Transcaspian region in was respectively 5784 thousand of heads and 457 thousand of heads without taking into account their livestock in Lebap and Dashoguz regions. The enormous loss of livestock was substituted with the coming of the Soviet regime. The significant part of the cattle is slaughtered to the meat and was driven away beyond the country borders. In 1941 on the entire territory of Turkmenistan there were remained only 2596 thousand head of small livestock and 79 thousand heads of camels.

At that time the camels basically used as working animal and they widely were used on the agricultural works, for the loads transportation the fulfillment of tillage, treating of soil, etc. Therefore the main direction of stock-breeding work was connected with further consolidation of sizes and increase in the living mass, which should lead to an increase in its general capacity for work. The current selection allowed to get a heavy and high productive Arvana breed for milk, meat and wool.

Introduction

In Turkmenistan, the reared dromedaries are of the Arvana breed created as a result of long selection. The pasture conditions in Karakoum desert which occupy area more than 38 millions ha make possible to maintain significant camel herds. They use as the fodder an upper part of the bushes which is suffrutescent and do not limit the possibility of the growth of sheep and goats livestock.

Camels do not disrupt the ecology of deserts, as showed the special studies by Research Institute of livestock and veterinary science [6], owing to the soft and wide sole of legs they do not harm the root system of grassy vegetation, which grows on the poorly fixed sandy soil.

Table 1. The changing of basic ranges of dromedaries (on V.V.Donchenko, 1956) [2].

Ranges, cm	Djebel Camels farm		Mary Camels farm	
	1937	1950	1937	1950
	Males			
Height in withers	189.20	193.96	-	196.86
Slanting body length	164.44	167.58	-	168.41
Chest girth	220.20	224.97	-	228.41
Metacarpus girth	24.68	24.39	-	25.64
Females				
Height in withers	174.74	179.30	176.98	184.71
Slanting body length	152.48	156.24	148.71	156.25
Chest girth	203.13	208.20	205.27	213.80
Metacarpus girth	18.59	19.40	19.26	19.54

Camel Population in Turkmenistan

Because of the extreme insufficiency of irrigation water in the territory of Turkmenistan for many years, the basic form of animals remained sheep and the camels, their number in the former Transcaspian region in 1914 according to the data of B.F. Kondakov [5] was respectively 5784 thousand of heads and 457 thousand of heads without taking into account their livestock in Lebap (which at that time related to Bokharan Emirate) and Dashoguz (it was subordinate of Khiva khanate) regions. The enormous loss of the branch of livestock was substituted with the coming of the Soviet regime. The significant part of the cattle is slaughtered for the meat and was driven away beyond the country borders. In 1941 on the entire territory of Turkmenistan there were remained only 2596 thousand head of small livestock and 79 thousand heads of camels.

Camel Selection and Improvement Strategy

At that time the camels were basically used as working animal and they were used widely for agricultural works, for loads transportation, the fulfillment of tillage, treating of soil, etc. Therefore the main direction of stock-breeding work was connected with further consolidation of sizes and increase in the living mass, which should lead to an increase in its general capacity for work. According to the data V.V. Donchenko [2], in this correction there were achieved the specific positive results.

As is evident from given data at the directed selection, the camels of the Arvana breed show sufficiently high increase in mass and indices of measurements in a comparatively short period. This positively affected the type of the animal's constitution, they became more massive. During the subsequent years because of the limitation in quantity of cattle in private farms there did not occur sharp increase in the camel livestock which it achieved only 120 thousand heads in 1990. During the years of the independence of Turkmenistan

after the cancellation of limitations, release of livestock breeders from the taxes, there is noted a tendency for an increase in the livestock population. At 2004 it was 124 thousand heads. According to the national program of the President of Turkmenistan on the development of the country economy for the period up to 2020 it is planned to bring the number of camels to 345 thousand heads.

Calculations and experience of the best leaseholders and farmers show that a yearly increase in the livestock of camels can be brought to 10-12%, and the capacity of desert pastures makes possible to maintain the growth of the number of sheep and goats up to 1 million heads in calculation of 30 hectares for 1 head. Consequently, the increase in the livestock of camels to 345 thousand heads planned up to 2020 is minimal. According to the most modest calculations it is possible to bring it to 0.5 million heads.

Milk and Meat Productions

The volumes of production are determined by demand. Over the long term the need in the products of camel breeding, especially milk, will grow, and the possibilities of their processing will be enlarged in connection with the conversion of this process on industrial bases. The dromedaries of the Arvana breed are bred for meat, milk and wool. During the lactation period (18 months) they can give up to 2500 kg of milk with fattiness 3.5-3.8%. From the milk there are made *chal* (sour milk) and *agaran* (cream), which have therapeutic properties.

Thanks to the high content of not saturated linolenic acid 3.13%, linolenic -1.09% olein – 3.54% of fatty acids, complex of vitamins and mineral substances, including of microelements, the special structure of proteins, amino acids, etc. camel milk is easily mastered and positively affects in the treatment of gastrointestinal and pulmonary diseases [4]. According to the data of G. Khodzhakulyev (1965) [4] after the use of camel's *chal* in a volume of 1,5 l per day by patients with chronic gastritis and secretory insufficiency the general state was improved in 15-20 days, the appetite of patients and symptoms of diseases disappeared. 85.4% of patients recovered, dimensions of the liver were normalized, decreased the signs of the bowels breakdown, cholecystopathy, functional disorder of nervous system. *Chal* made from the camel milk is recommended as therapeutic preparation for the patients with chronic gastritis.

The production of milk and dairy products has increasing commercial importance. The tentative production of milk at present reaches 2-3 thousand tons per annum. There are farms which are specialized in the production of camel's milk and dairy products.

These are perishable products and there were made the attempt [1] to subject them to lyophilization. Obtained data confirmed this opportunity. In the process of lyophilization the content of base materials (proteins, fats, lactose and others), the lactic acid bacteria, yeast(s), bacteriological, biochemical and other indices in within 3 months of storage at the room temperature did not change.

The obtained therapeutic product "Bereket lyophilized" was acknowledged useful for preventive maintenance and treating the placental insufficiency. But because of the high prime cost this technology is not widely applied.

At the present, the stock-breeding work in the camel breeding is directed on increase in the milk-producing capacity, meat and wool productivity of animals. Mainly it is conducted on the stock-breeding farms: State breeding farm "Sakarchaga", Mary, stock breeding sovkhozes "Turkmenistan" of Balkan, "Erbent" of the Akhal region. In these farms the best part of the stock-breeding camels is concentrated. They provide other farms with pedigree bulls.

Under the researches by the Livestock and veterinary sciences Institute at the State camel farm "Sakarchaga" there were defined 3 productive camels types of the Arvana

Table 2. Indices of the ranges in camel dams of different types (K. Geldiyev, C. Cholukov, 1979) [3].

Index	Woolen meat type	Milky-meat type	Meat-woolen type
Living mass	596.4±7.56	581.8±8.26	612.5±5.92
Height in withers	185.0±0.83	182.4±0.68	185.5±0.45
body length	174.5±1.01	173.6±0.77	177.5±0.70
Chest girth	202.5±2.45	210.4±2.27	214.5±0.92
Metacarpus girth	19.55±0.10	19.53±0.11	19.6±0.08

Table 3. The characteristics of camel's line in State camels farm "Saakarchaga".

Lines	Total heads	Including		Productivity		
		Bulls	Dams	Milk yield \x,kg	% fat	Wool clip, kg
Batly	249	7	118	1326	-	2.4
Selen	321	6	120	1275	-	2.2
Gavers	211	5	77	1292	-	2.0
Garagulak	156	4	60	1173	-	2 2.6
Gek Gaplan	96	4	30	1139	-	2.1

*for milking period of 170 days.

breed: meat-woolen, woolen-meat and milk-meat. Each from them has its own features on body constitution and development of milk, meat and wool productivity (table 2).

Animals of the above productive types differ on mass of constitution. Meat-woolen type is more massive and their living mass is higher than of the other types indices on 3-5%. They are bonier. They have higher indices of living mass, ranges, chest girth of 2.0-6.0% more than other types have.

The female camel of milk - meat type has better developed milk criteria, most of them had the cup-shaped and rounded form of udder, and according to this index they exceeded wool- meat type animals to 20%, meat- woolen type to 16.6%. On another group this superiority reached respectively 23.1% and 25.5%. Such differences between the animals belonging to the different types are in the indices of woolen productivity.

The improvement of the Arvana breed is accomplished in the stock-breeding farms through linear breeding taking into account the belonging of camels to the different productive types.

As can be seen from the table 3, the most productive type is the Batly type.

On the animals, productivity indices of this type exceed the other one [8].

Early Weaning

Camel breeding is extensive branch of stock rearing. Development of camels is continued up to 7 years, females go into the coupling at the age of 3.0-4.0 years, the males - at the age of -4.0 and older, suckling period of young camel continues 18 months.

Under the studies of the Research Institute of livestock and veterinary science [7] there were made attempts of early (at 9-10 months) weaning of young camel with their additional feeding.

Table 4. Daily ration of feeding of early weaned young camel.

Forage	kg	Fodder unit	crude protein,g	Calcium g	phosphorus, g	salt, g	carotene, mg
Mixed fodder	2	2.0	300	10.4	13.4	-	-
Lucerne hay	5	1.35	150	46.0	7.0	-	7.0
Cotton husk		1.05	51	9.3	5.1	-	-
Salt	0.03	-	-	-		30	-
Total		4.4	501	65.7	25.5	30	7.0

Besides feeding the young camel there are pastures used. Camels grew normally with this feeding. In comparison with the control group of young camel, early weaning increased in weight for 12 months: on 5.7 kg in males, on 2.0 kg in females, and in 17 months the males from experimental group gave on 51.7 kg more increase in weight.

Thus the early weaning (at 9-10 months age) ensures the normal development of young animals. The general fodder's consumption in fodder units per head was 924 kg with a cost of 556 thousand manats (about 100$), and the realization price of increase in weight (51.7 kg) was 775 thousand manats (about 140$). Profit from the early weaned young camel was 220 thousand manats (about 42$).

Conclusion

In future, the work will be continued on the intensification of camel production by focusing on the early heat for camel's dams, earlier (in 18-24 months) use of females for reproduction, and use of the males (18-20 months) to slaughter for the meat. It is important to develop the more effective technology of camel milk preservation, to study the therapeutic properties of camel milk and further to improve the practices. Together with a significant increase in the livestock there will be accepted measures for the use of the camel milk and woolen products, the adoption of the industrial technology of their processing.

References

[1] **Chagylov K., 1994.** Hygienic characteristic and the substantiation of the rationalization of the population nourishment in Turkmenistan. Author's abstract of thesis to the competition of scientific degree, doctor of medical sciences, Almaty.

[2] **Donchenko V.V., 1956.** Dromedary of Turkmenistan and way of its improvement. Transactions of the institute of stock raising, volume 1, Ashgabat.

[3] **Geldiyev K., Cholukov C., 1984.** Increase in the milk, meat and woolen productivity of the camels of Arvana. Veterinarian science in the fulfilment of food program. Ashkhabad.

[4] **Khodzhakulyev G., 1965.** The *chal* and its therapeutic properties. Author's abstract of thesis to the competition of the scientific degree of the doctor of medical sciences, Ashkhabad.

[5] **Kondakov B.F., 1960.** "To the history of stock raising in Turkmenistan" (1914-1945). Transactions of the Turkmen scientific research institute of livestock and veterinary science, Ashkhabad.

[6] **Musakarayev T., Saparov G., 1980.** To create the milky thoroughbred type of the camels of the Arvana breed in state farm "Sakarchaga" with the milk yield 2500 kg, the fat content 3.8% and a living mass of 500 kg, Ashgabat, 1980 final report of NIIZHIV.

[7] **Saparov G., 1999.** The feeding of young camel with their early weaning. Development of stock raising - scientific guarantee, Ashgabat.

[8] **Saparov G., 2003.** The restoration of the genealogic line of the Arvana breed camels and increase in the selective stock-breeding work into state camels farm "Sakarchaga". Final report of Research Institute of livestock and veterinary science for 2000-2002 Ashgabat.

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The Camel and Society

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Abstract. The camel, since its domestication, 6000 years ago [4] has mainly had a utilitarian role, and man has always maintained emotional and symbolic links with him, the importance of which might be proportional to the dimensions of the animal and to the services he provides to the men of the desert. This attraction has lasted until present times in the Southern as well as in the Northern countries, obviously for different reasons.

Mauritanian Moors describe the desert as a huge dromedary herd in which each dune represents a lying animal. This way of describing landscape allows nomads to memorise a route and to explain it to others. Dromedary fulfils the dreams of some of us, helps others to describe their environment, and has been inspiring poets from the pre-islamic times to the present.

But it also recalls cliched imagery based on ignorance and prejudice, which confine it to the past or even obsolete positioning. This ambiguous relationship is reflected in social behaviours, in popular symbols and in the ways some development policies are being implemented. Nowadays, relationships with the camel in both Northern and Southern societies respond to two diverging trends: on the one hand marginalisation, on the other hand idealisation.

1. Dromedary, a Marginalized Animal

In development agency jargon, desert areas are referred to as "remote areas" and the dromedary considered as a remote, marginalized animal. Dromedary has two handicaps, in developers' and funders' eyes: 1) he is heavily constrained to live in a determined environment (unlike cows and small ruminants for example), 2) their number (around 20 million) is ridiculously small compared to the cattle population (around 1.3 billion) and the ovine-caprine population (about the same number).

As a matter of fact, the hyper-specialisation of the species to the living conditions of the desert regions, made it difficult for him to adapt to other ecosystems, unlike other ruminants like bovines, ovines and caprines the genetical plasticity of which has made them easy to widely spread around most ecosystems in the world. In that sense, one could compare dromedary with the yak, which cannot be found much beyond the mountain ecosystems of Central Asia.

1.1. Dromedary, the Animal of the Rebels

The outbreak of the Tuareg rebellion in 1990 in Niger, then in Mali and before that, that of the Tubu in Chad, brought to light the despair of nomad cameleers and their request to be recognised and respected by the public authorities. The exclusion of the people of Central Sahara has its origins in a process, which started in the 60s-70s and in the conjunction of several political and economical factors:

1) *Prohibition of caravan trade and lorry competition.* By the time the countries, which used to breed camels and dromedaries acquired their independence, the caravan trade was forbidden: Tuareg from Niger and Algeria could no longer "nomadize" from one country to the other. Neither could they trade with their caravans. In Niger, anyone caught in the act of caravanning was condemned to a 3-year prison sentence and confiscation of all his goods and camels. Paradoxically, lorries could freely go on trading dates and millet between Algeria, Niger and Mali.
2) The extension of cotton and rice cultivated areas reduced pastoral areas, thus transforming the traditional complementarities between nomads and settled people into rivalry.
3) The implementation of a tax on cattle and people together with the repeated draught of 73-74 and 84-86 largely contributed to destroying a very fragile (precarious?) way of life.
4) To permanently get rid of the Tuareg people, central governments have gone so far as to poison wells and goods, have diverted international aid and displaced whole populations.

50 years before, in Central Asia, namely in Kazakhstan, the collectivisation of herds and forced settling imposed by the Stalinian power had pushed nomads into sacrificing their herds or fleeing to more hospitable areas: Kazakh animal population thus fell from 1.200.000 animals in 1927 to 104.600 in 1941 [14].

So, in many countries, namely in those where political power has fallen into the hands of sedentary people, the camel, being considered as the animal of the nomads, who, being mobile and careless of frontiers, are by essence, difficult to control, has been marginalized or repressed just like his cameleers.

However, some political conflicts may have had locally some positive by-effects. Western Saharan conflict in Morocco in the 70's and Niger's conflict have aroused a renewed interest for camel breeding by the public authorities looking for a political response to the development issue of the rebelled regions. As a matter of fact, following these conflicts, development policies of camel breeding were implemented in Morocco and camel population grew from 70.000 in 1985 to 149.000 according to the last census whereas they had fallen by 56% between 1971 and 1985 [6]. With the background of the Tuareg rebellion, a development scheme of camel breeding was also implemented in Niger's central region [15].

1.2. Dromedary, a Symbol of the Past

For a number of political decision makers and development agencies, including in countries with a strong pastoral tradition, dromedary, the nomads' animal, is considered as a symbol of the past in the same way as nomadic life itself, as a mode of breeding, in the countries where sedentary life has become an equivalent of modernisation. In industrialised societies, dromedary is commonly reduced to caravan use, and so doomed to disappear due to the competition of lorry. In such conditions, dromedary only represents a "has been" of the desert economy, only good for tourism, a survival of the past, obsolete and marginalized.

In the field of zootechnical production, namely milk production, the cow fashion, the demographic productivity of which is twice as high, (shorter gestation period, shorter interval between giving birth and milking duration), may have contributed to this phenomenon. However, such a definite choice which was particularly strong in the 80s', has sometimes driven to real humanitarian disasters during the 1998 draught, namely in Somalia, where the cow seemed to be the animal of the future. As a matter of fact, the bovine owners were much more heavily stricken by the loss of cattle than the dromedary owners [2].

In the desert, modernity goes with motorisation. Even political armed conflicts or insecurity due to a predatory economy rely on the speed of 4 by 4 rather than on that of dromedaries. Although some camel corps have reappeared here and there (in Mali, Mauritania and Niger), and some veterinaries auxiliaries of Sahelian regions still ride camels, the sign of success for economical actors who have succeeded in the desert economy is to drive a 4 by 4 and have a cell phone. At best it appears as symbolical relics of an ancient culture. This aspect culminates in the countries of the Arabic Gulf, where dromedaries themselves are transported in lorries and where possessing a camel can be compared to having a Bedouin tent in the desert, a few miles away from the high standard comfort of the futurists cities, and going there for the week end, thus recalling ancestral traditions, just like restored medieval wells, which no longer work, or old repainted carts decorating some weekend houses in Western countries.

With the race towards modernisation, camels have lost their hegemony as the auxiliary of man in steppes and in deserts. So, one can now easily understand why camel scientists may appear as eccentrics or marginal people, provoking at best slight amusement among specialists of more common species, and sometimes slight contempt towards scientists working on a species dealt with by only a hundred or so of serious publications every year that is to say 20 to 40 times less than on cows.

1.3. Dromedary, an Animal for Circus and Zoos

Although, by comparison, the camel has played a minor role in Western societies, it has been present for a long time as a leisure animal in zoos and circuses. This reflects the status given to him by the public: an exotic animal, the productive breeding of which is hardly ever imagined as it is the case for other domestic species but which can be shown as a symbol of a remote world, the desert. In this context, he is treated as a wild animal, which has been captivated and «acclimatized[1]» for the pleasure of the urban population in search of exotism. This sounds quite far away from the conception of an animal of zootechnical interest with a major economical role in several desert countries.

A profound lack of knowledge together with some cliches on the physiological characteristic of camel are very widely spread among these Sunday urban visitors, the most common of them being that the hump is a water reservoir, a glaring mistake about the animal physiology which can be found even in encyclopedia for young people (“Ma première encyclopédie” Hachette editor).

1.4. Dromedary, an Undervalued and Ill-Treated Leisure Animal

Accustomed to large open spaces, the dromedary is often enclosed in very small areas. He is sometimes used to carry small children on his back but his use as a transport animal and his incomparable characteristics are very seldom mentioned. Nothing is said on his milk, meat and wool production. Very little is known about his role as a domestic animal essential to the populations of desert areas.

Camels are sometimes used by some ignorant improvised breeders who use them in circuses and parades without having any knowledge of their real needs. Some of them, victims of their reputation of abstemiousness, were given no water during the European draught of August 2003 and died from it.

This lack of recognition is also reflected in France by the fact that there is no identification registry for camels, although it is compulsory for most domestic species (there is even

[1] In Paris, dromedary was one of the first species hosted by the « Acclimatization garden ».

one for lamas). Camel milk as a nutritional good is totally ignored by the European regulation[2], which makes its exportation to Europe and its commercialisation very problematic as in the case of Tiviski milk factory in Nouakchott, Mauritania [1].

1.5. The Dromedary, A Forsaken Animal, Thrown Back to Wilderness

Dromedaries were imported to Australia in the 19th century in view of exploring the large desert area of the centre of the continent. They were gathered in yokings of a dozen animals and used to track heavy burdens such as rails and railway sleepers across Simpson Desert. Before the motorisation of agriculture, they were used as an auxiliary in the agricultural activities. But once their contribution to the modern infrastructures equipment of the country and to the multiple agricultural tasks was no longer needed, they were simply thrown back to wilderness.

As no predators threatened them, their number increased considerably and they are reckoned to be between 100.000 and 500.000 today [11]. As a tribute to these dromedaries and to the Afghan cameleers who used to drive them, the train crossing the country from North to South, is called "the Ghan", short for "Afghan" and has got a sign with a mounted camel on the front of its engine as a modest tribute to this pioneer of the conquest of the bush.

Researchers took benefit of this situation to use this unique herd for their research. They can better understand the behaviour of the dromedary species away from human influence [12]. However this marooned herd is now becoming an issue as the rapid demographic increase of this population is starting to exert a certain pressure on the environment. At the limits of the desert the wild dromedary starting to compete with domestic species, a *camel destruction act* was adopted in 1925, authorizing to slaughter animals exceeding the right number. During the drought of 1961, 1150 animals were killed in the vicinity of three waterholes [17]. More recently, it has been decided to organize big captures in view of exporting to the Gulf countries, very fond of dromedary meat.

2. The Dromedary, High in Man's Esteem

Although hampered by natural catastrophes and negative trends in society (war, drought, abandon of the sedentary way of life, declining pastoral livelihood etc.) camel-raising populations remain viscerally attached to their animals, which symbolize cultural traditions: in the words of an ancient Touareg proverb, "In the beginning was the camel Fakaru, whose milk nourished the entire world". In addition to this attachment, the camel has been the object of an idealization – sometimes lending it a quasi-mythical status – that has even affected the scientific community.

2.1. Idealization of the Dromedary

The dromedary's anatomy and physiology have long fascinated desert travelers and researchers. Its unusually long neck, hump, rolling gait, legendary impassivity and extraordinary capacities of endurance are indeed strange. Its compatibility with desert peoples who share its asceticism has fascinated those with a taste for the absolute. Credited with unique "authenticity", the desert's inhabitants – man and beast alike – have fascinated for centu-

[2]In the *Codex alimentarius* milk is defined as the product of the milking of a certain number of female mammalians for commercialization. The female camel isn't mentioned in the list of concerned animals.

ries. The dromedary is of course an indefectible member of the camel trek, an increasingly popular "back to basics" break from modernity – venturing out into the austere environment of the desert to rediscover a simpler way of life, sleeping outdoors, living off camel milk and bread cooked in the sand, and measuring time by the deliberate steps of the dromedary.

In Europe and the United States, this idealization has broadened into a more general interest in camelids. Examples include adopting llamas as pets, camel enthusiast associations, organized camel treks and several well-publicized international competitions like the Dromedary Marathon in Douz, Tunisia, or the Camel Derby where the jockeys of Alice Spring in Australia and those of Virginia City (USA) meet every year.

In developing countries, the dromedary still above all symbolizes the nomadic cultural identity. A number of cultural events are focused on the camel. The dromedary is a key feature of desert festivals in places like Tunisia, Algeria and Mali. In the Targui area – Mali and Niger – the *Cure Salée* is not only a transhumance necessary for the health of the animals but also a means of reaffirming the Touaregs' nomadic identity [3]. In the Sahel, the animals are protected against the evil eye. In the fair at Pushkar, India, the female camels are decorated with makeup and jewels, sometimes exaggeratedly elaborate.

Products such as camel milk also play a role in the defense of cultural identity. Settled and urbanized people often still shun cow's milk, preferring camel milk to which they attribute healing and energizing properties. In Central Asia, traditional dairy products derived from camel milk are associated with a specific area or country. Cures based on these products are prescribed to ensure robust health. As Mauritanian men prefer their wives plump, the latter are put on a fattening diet of camel milk and dates.

Finally, reputed members of the scientific community have become ardent defenders of the dromedary, praising its remarkable capacity of adaptation to desert conditions. Some even consider it a key factor in the battle against famine and desertification, a potential champion in preservation of the environment. To these thinkers, the dromedary can be a miracle remedy to the problems facing arid countries.

2.2. The Dromedary, Champion of the Desert Sands

In the Arabian Gulf, dromedaries are raised to satisfy an urbanized and often wealthy Bedouin population, very fond of camel races. These competitions are well-established institutions. A big amount of money is invested to finance racing infrastructure and laboratory research on the physiology of effort and on care and feeding of the best racers. Prices of blue-ribbon specimens reach astronomical levels, comparable to those bid for top Western thoroughbreds. Champions are cosseted, with every possible attention paid to their diet, comfort and training.

In countries where sports activities are less elitist, camels are sometimes raised for leisure use only. In Algeria for example, transporters who can afford it reconvert to trucking. This has been the case of the Ben Mansour family, members of the Chaambas tribe (Ouargla). However, they remain passionate camel lovers. Though no longer a beast of burden, the swift dromedary – which once bore raiders on legendary *razzias* and then served in the Camel Corps units of the French colonial army – is still the desert thoroughbred. The races enable the Ben Mansour to revive the long-gone era when the camel was the king of the desert.

More generally, the dromedary is gaining popularity as an animal for leisure use. Dromedaries are employed in developing countries for desert tourism, while organizers in industrialized nations offer camelback mini-treks in the dunes and back country of European coastal areas to amateurs lacking the means to venture out into the vast Sahara. Camels are sometimes featured in local urban and village festivities. In Australia, the dromedary

has been virtually abandoned as a productive animal and is now exclusively exploited as a leisure animal. Some 40 Australian companies organize desert trips on camelback.

3. The Dromedary in the New Millennium: Myth or Reality?

The place of the "friend of the nomad" in the third millennium is closely related to the destiny of the nomad himself.

Two factors are key to understanding possible trends in the relationship between the dromedary and society: first, the discovery of the animal's zootechnical potential, that's to say developing livestock productivity in the desert; second, the increasing interest of the scientific community in the dromedary as a biological model.

3.1. From the Ship of the Desert to Productive Livestock

Europeans have difficulty imagining that dromedaries can be raised for meat and milk, or even used to work farms. Few, for example, know that certain – well-fed – camels produce far more milk than cows rose under the same conditions. Industrial camel milk production is a recent development, notably in several sub-Saharan cities and in Saudi Arabia, where production has reached intensive levels.

Concerning meat production, traditional demand in the Horn of Africa has enabled local breeders to expand onto the international market. Livestock is now exported, mainly from Somalia as well as from Sudan, Ethiopia and Djibouti, to the countries of the Arabian Peninsula. In the last few years this commerce has encountered competition from Australia, which exports approximately 10,000 camels yearly, worth about $1.52 million and destined primarily for meat. Sanitary problems in the Horn of Africa may enable the Australians to increase annual shipments to 25,000 head in coming years.

In addition to meat and milk, camel energy is also on the upswing. Although the dromedary is best known as a saddle animal and beast of burden, it has been used for farm work since ancient times in India, Morocco and Ethiopia. New roles have been observed more recently. Examples include household waste collection in Nigerian cities and, less important economically, the camel-libraries in India and Kenya, where dromedaries carry itinerant lending libraries from village to village.

To sum up, countries with camel populations are discovering the zootechnical potential of the dromedary, capable of significantly contributing to desert productivity. Above and beyond milk and meat production and use of its energy dating back to domestication of the species in the distant past, commercial production is relatively recent, accompanying urbanization of cities located in desert regions. This has resulted in, for example, sale of pasteurized or processed camel milk in supermarkets in certain regions, and camel meat butcher shops are spreading in Tunisia. Improvements in food processing technology have enabled new products such as camel milk cheese and camel sausage to be marketed, bringing the dromedary into the modern food and agriculture industry [5].

3.2. Renewal in Camel Studies

While camel livestock has been integrating commercial networks, scientific research on the camel has revived considerably over the last three decades. The first studies, by Buffon, date back to the 18th century. This research reached its peak during the colonial era, especially in France, and in Great Britain to a lesser degree. Camels were widely used by the French, who administered vast desert regions, and memorable contributions were made by their veterinarians. Publications and documentation were particularly abundant around the

middle of the 20th century. Some of these works, such as that of Curasson on dromedary diseases (1947), remained reference works for decades.

Camel research, after undergoing a decline while African and Asia nations were gaining their independence, was revived in the early 1970s. The most important events since then have been the Colloquiums and Congresses of Khartoum (1979), Ouargla (1988), Paris (on reproduction, 1990), Dubai (1992), Nouakchott (on milk, 1994), Eilat (1996), Al-Ain (1998 and 2002), Ouarzazate on the baby camel (1999), Almaty (2000). An international scientific community devoted to camel studies has gradually emerged[3].

The latest trends of these studies have been presented in the current conference [10], notably research on the dromedary as a biological model, as a producer of high value-added food products and research on its key role in desert ecosystems. In rediscovering its biological and ecological qualities and livestock potential, science makes it clear that the species has significant contributions to make in the third millennium.

Conclusion

In the globalisation era, the dromedary has regained its function of bringing people together after losing this role with the abandon of the caravan routes. The dromedary's renewed prospects are founded on use as an animal of leisure, commercialisation of camel milk dairy products and on its role in the overall battle against desertification. In light of growing ecological awareness and justifiable concern for the future of the planet, it is particularly appropriate and timely to recall that the dromedary's role in halting expansion of desert areas is unique and indispensable. As its milk productivity is higher than that of bovines, replacing cows by camels diminishes the livestock herds' impact on the environment. Camels' feeding habits spare small trees and entail consumption of a wide variety of plants, in sharp contrast to bovines' "saturation" grazing that necessitates bush fires. Moreover, camels' greater mobility, resulting in optimal coverage of grazing acreage, and their resistance to thirst enable herders to nourish their stock in areas poor in water but rich in grass. Dromedaries' dispersed grazing and soft, supple hooves are much less destructive to land than more concentrated trampling by bovine herds, and therefore less subject to cause soil erosion. Thus the dromedary contributes to preservation and durable utilization by man of arid and semi-arid areas.

Confirming the dromedary's role in limiting or even halting the advance of deserts will make it an animal of the future, not of the past, enabling it to take its real place, neither marginalized nor idealized, but as a contributing player in the economies of desert regions' populations.

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[3] **Ouargla Seminar - 1988**: "Séminaire sur la digestion, la nutrition et l'alimentation du dromadaire" (Seminar on dromedary digestion, nutrition and alimentation), Options méditerranéennes n°2, CIHEAM, Paris, 187 pp.
Paris Workshop - 1990: "Peux-t'on améliorer les performances de reproduction des camelins?" (Can we improve camels' reproduction performances ?), Editions CIRAD-EMVT, collection Etudes et synthèses de l'IEMVT, CIRAD-Montpellier, 437 pp.
Dubaï Conference - 1992: "First International Camel Conference", Editions R&W Publications Ltd, Amersham, 431 pp.
Nouakchott Workshop - 1994: "Chameaux et dromadaires, animaux laitiers" (Camels and dromedaries, milk animals), Editions CIRAD-EMVT, Montpellier.
Eilat Conference - 1996: "Camelids: science and productivity", Journal of Camel Research and Practices, Bikaner (Inde).
Ouarzazate Workshop, 1999: International workshop on young camels: "le Chamelon, futur de l'élevage camélin" (young camel, the future of camel breeding). Ouarzazate, 24-26 oct. 1999, Maroc.Rev. Elev. Méd. Vét. Pays trop., 53.
Al-Ain Meeting : Proc. 3rd ann. meeting for anim. prod. under arid conditions. Al-Ain, May 2-3, 1998., U.A.E.

References

[1] **Abeiderrahmane N.,** 1997. Camel milk and modern industry. J. Camel Pract. Res., 4, 223-228.

[2] **Bonnet P., Faye B.,** 2000. Enjeux zootechniques de la famine en Ogaden. Les Nouvelles d'Addis n°18. Août 2000, p.15.

[3] **Caballion S.,** 2003. Eléments pour une anthropologie du « système domesticatoire » touareg. Ecoles des hautes études en sciences sociales. Juin 2003.

[4] **Epstein H.,** 1971. History and origin of the african camel. *In:* The origin of the domestic animals in Africa. New York, African Publishing Corporation, 558-564.

[5] **Farah Z., Fisher A.,** 2004 (Eds). Milk and meat from the camel. Handbook on products and processing. Vdf Hochschulverlag AG publ., Zurich, 230 p.

[6] **Faye B., Bengoumi M.,** 2001. La santé du dromadaire : une contrainte majeure de l'élevage camélin en zone pastorale. *In:* colloque « santé et pastoralisme », Maghreb Vétérinaire, Rabat, 25-28 avril 2001, 8p.

[7] **Faye B., Grech S., Korchani T.,** 2002. Le dromadaire, entre féralisation et intensification. *In:* Domestications animales : dimensions sociales et symboliques. VII^{éme} coll. Int. HASRI. Villeurbanne, 21-23 nov. 2002 (sous presse).

[8] **Faye B.,** 2003. Surveillance and control procedures for camel diseases. Workshop on the surveillance and Control of camels and wildlife diseases in the Middle East. Regional workshop OIE, Sanaa (Yemen) 10-12 march 2003.

[9] **Faye B.,** Bengoumi M., Barkat A., 2003. Le développement des systèmes camélins laitiers péri-urbains en Afrique. Atelier Int. sur le lait de chamelle en Afrique. FAO-CIRAD-KARKARA, Niamey (Niger), 5-8/11/03 (sous presse).

[10] **Faye B.,** 2004. New trends in camel sciences. Workshop on "desertification combat and food security: the added values of camel producers. Ashkabad (Turkmenistan), 19-22 april 2004 (in press).

[11] **Gees P.,** 1996. The camel in Australia. J. Camel Pract. Res., 3(2), 139-140.

[12] **Heucke J., Dörges B., Klingel H.,** 1992. Ecology of feral camels in central Australia. Proc. 1st Int. Camel Conference. W.R. Allen, A.J. Higgins, I.G. Mayhew, D.H. Snow and J.F. Wade (Eds.), Dubaï, 2-6 feb. 1992, U.A.E, Publ. R&W Ltd, 313-316.

[13] **Konuspayeva G., Faye B., Serikbaeva A.,** 2003. Les produits laitiers traditionnels à base de lait de chamelle en Asie Centrale. Atelier Int. sur le lait de chamelle en Afrique. FAO-CIRAD-KARKARA, Niamey (Niger), 5-8/11/03.

[14] **Moussayev Z.M.,** 2002. le Селекционно- племенная работа в конневодстве и верблюдоводстве Казахстана Материалы 1 международного ветеринарного конгресса 10-11 октября 2002г. Almaty, Kazakhstan, стр 101-103.

[15] **Pacholek X.,Vias G., Faye B., Faugère O.,** 2000. Elevage camelin au Niger : référentiel zootechnique et sanitaire. Publ. Coopération Française, Niamey, Niger. 93 p.

[16] **Schwartz A., Dioli M.,** 1992. The one-humped camel in eastern-Africa. Editions Verlag, Weikersheim (Allemagne), 282 pp.

[17] **Wilson R.T.,** 1984. The camel. London, Longman Publ., 223 pp.

[18] **Yagil R., Van Creveld C.,** 2000. Medicinal use of camel milk-fact or fancy? Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100.

Session 1

Desertification, Selection, Breeding and Diseases of Camels

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Desertification Combat and Food Safety
B. Faye and P. Esenov (Eds.)
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Camel – History of Its Domestication

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Turkmenistan

Abstract. The camel is present in Turkmenistan for a long time and was used mainly for traction. Some archeological traces are still existing to certify the presence of Bactrian camel and dromedary camel in some parts of the country several millenniums ago.

No need to explain anyone – how important camel is in a farm. From time immemorial camel is serving people, inhabiting dry steppes and fruitless deserts. Unpretentiousness helps camel to survive in the most difficult conditions of heat and lack of water. Camel was irreplaceable for ages. It provided meat, milk, wool, leather, whilst in a distant crosses over the desert camel were carrying big loads and has been used under a saddle.

Dromedary (Arabian) camel is prevailing in Turkmenistan. Bactrian camels are mainly cultivated in the north-west, partially south-east. But this was far not always the case. Our territory lies within a wide spread area of Bactrian camel. So, it could be assumed that South Turkmenistan was one of the centers of domestication of this animal, which is proved by findings of wild-camel traces in geological deposits of Western Kopetdag, place called Gyavurlee, aged 2.5 million years.

When exactly the man domesticated this noble animal – camel? Science does not possess any actual confirming data yet. People acquainted with camel long ago, at the times of ancient Stone Age, hundreds of thousand years ago. Camel's bones are quit often being met at the Paleolithic period settlements. While progressing to the productive housekeeping, including cattle breeding, people highly appreciated camel's features as a domestic animal. It is believed that Bactrian camel was domestic back in V millennium BC, the most ancient remnants are known from the Neolithic layer of the north Anau hill. Such archaeological memorials are widespread along Kopetdag and Iranian territory, therefore area of Turkmen-Horasan Mountains is recognized now as a homeland of domesticated Bactrian camel. It is clear then that domestic "Bactrian" has no any conjunction with Bactrian – ancient state on the territory of North Afghanistan, Tajikistan and South Uzbekistan.

As traction force camels were being used by ancient farmers of Turkmenistan along with the horses back in IV-III millennium BC, which is proved by archaeological materials. Presence of camel bone-remains in the burial ground dated IV millennium BC – Tummek-kitchijik, North Turkmenistan, shows that this animal was widely used as a traction force. Giving that domestication of the horse by Neolithic tribes of Ural region occurred back in VI millennium BC, followed by the same domestication achieved by the cattle-breeders of Eurasia steppe, including Turkmenistan, then "acquaintance" with camel could have happened no later than the same millennium.

Bones of Bactrian camel were also discovered by archaeologists in the latter layers, referred to the epoch of Bronze. Ceramic statuettes of camels, harnessed into a model of a four-wheel carriage, dated III millennium BC, are particularly interesting. Archaeologists had lots of discussions as to who is shown in these statuettes – a camel or a horse? Argu-

ments in favour of camel look more convincing: proudly raised head on a long neck, peculiarity of a mane and a hole pricked in a nostril for a stick to put in. Consequently camel was transferring heavy weights in carriages in the epoch of Bronze. Usage of camel for riding purposes is very likely but not proved yet.

Ancient tribes of Indo-European breeders became familiar with Bactrian camel later than ancient farmers. They have enjoyed a new animal so much that with the time being it even became religious – along with horse, bull and sheep. Ritual burials of camel's bones and skulls in burial grounds, clay statuette, camel stone-head and lots of camel images on petroglyphes in Kazakhstan are evidences of that.

Images of Bactrian camel are observed in amulets and on the vessel-sides of Margiana, dated II millennium BC. In the historic times, approximately in the first millennium BC, images of Bactrian camel are presented on the walls of royal portrayals of Akhemenids. It is interesting that Akhemenids had an extensive conquest, including the lands of a former Assiriyan kingdom, where Dromedary camel has been used from a long past, being borrowed from Arabs. The spread areas for both camels were not really mixed two and a half thousand years ago.

From the ancient times an interesting phenomenon is being noted – camel terminology affects people names. This probably reflects an ancient cult of this animal and respective attitude to it as to a source of vital weal. Even the name of prophet Zaratustra means the "owner of golden camels".

Another historic parallel is given by the ancient materials of north-west Turkmenistan. There are images of a rider on a Bactrian camel represented on a belted water-bottle. On the coins of the last centuries BC there are images of laying Bactrian camel – as a detail of a royal crown. This image reflects camel's cult, formed in the areas of Central Asia among the breeder's tribes.

Wide spreading of a dromedary camel likely occurred after Arabian conquest.

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Participatory Approaches to Using the Camel in Combating Desertification

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Abstract. The paper describes the place of camel in the Indian society and economy, especially in Rajasthan. In a current project, the improvement of camel use was supported by a participatory approach for production and disease prevention.

Introduction

The potential of camel husbandry for food production in arid areas is well appreciated among camel scientists and some ecologists. Nevertheless, camel populations are witnessing a steep downward trend in most Asian countries, including China, Mongolia, most of the Central Asian republics (except Turkmenistan und Uzbekistan), India and Pakistan. Using the example of India, this paper will argue that in order to prevent a further decline and eventual near extinction of this species in many Asian countries, it is necessary for one to adopt participatory approaches and focus research and development efforts on the needs and worries of the people whose livelihoods depend on camels. Equally or even more important, governments also have to create supporting policies by providing secure access to grazing areas and encouraging the marketing of camel products.

1. Camel Population Trend in India

India was once proud of having the third largest camel population in the world, after Somalia and Sudan. By 1997, the overall camel population of India had dropped to 911,000, according to the official data of the government, and it had been surpassed by Pakistan and Mauritania. This represented an 11.6% decrease of the camel population over the five year period since 1992. The number of young camels decreased even by 50% during this time period indicating a drop in camel breeding activities.

The results of the official livestock census conducted in 2003 are not yet available, but the decline seems to have accelerated since 1997 as indicated by our own surveys and by anecdotal information that will be detailed below.

73.43% of the population (669000 head) is at home in Rajasthan, the most western state of India, where the one-humped camel has traditionally had great cultural, social, and economic significance. Much of Rajasthan is desert and regularly experiences severe droughts; due to overexploitation for irrigation agriculture, ground water levels have been sinking rapidly, leading to the cessation of cultivation in some areas of the state. Despite this situation, water intensive animals, such as buffalo, have sky-rocketed in numbers, whereas

camel breeding is rapidly abandoned and the camel is the only type of livestock whose population is decreasing.

2. Socioeconomic Significance of the Camel in Rajasthan

The camel is often regarded as emblematic of Rajasthan. In Rajasthani folklore it symbolizes love and ownership of a camel once signalled status and wealth. It was used for warfare by the Maharajahs and played an important role in desert communication, transportation and trade. Camels were thus a valuable commodity used by the ruling classes and by the business community.

The breeding and supply of the camels required by the elite for battle and commerce was, and is, the traditional occupation of a Hindu caste known as Raika. Here at the eastern margin of the dromedary's distribution area, a unique human-camel relationship and camel culture has developed. As Hindus, the Raika are probably the only camel pastoralists in the world who have developed a deeply ingrained prohibition against the use of camels for meat. Their identity was traditionally based on the belief that they were created by God to take care of the camel. Therefore they regarded themselves as guardians of the camel in the true sense of the word, feeling responsible for the well-being of this animal. The community outlawed the sale of female camels, female camels were part of the dowry and for the marriage ritual the bridegroom had to be seated on a camel. Due to this intimate association with the camel over the centuries, the Raika also accumulated a large body of indigenous knowledge related to camel management, breeding, disease treatment, and behavious. For this reason, they were referred to as "native camel doctors" by colonial veterinarians.

Despite their continuing emotional linkage with the camel, it is now only a small minority of Raika for whom this animal forms the basis of subsistence. The majority of the Raika still involved in animal husbandry keep sheep and/or goats, serve as village cattle and buffalo herders, work as caretakers in gaushalas (cow-sanctuaries) or as traditional animal healers. Although such animal related occupations are still typical for the Raikas, many of them have severed all connections with livestock and invested profits from the sale of their herds in agricultural land, in the purchase of shops, or made fixed deposits in the bank.

The Raikas are an extremely conservative community long regarded as impenetrable to outsiders of all kinds (not just foreigners). Although there are some notable exceptions, the general level of education continues to be low, especially among girls. Most families now make the effort to provide at least one son with some semblance of education. But the level of literacy among the men actively engaged in animal herding and among the women is practically nil. The majority of young men seek wage labour outside Rajasthan, mostly in menial jobs which usually pay little more than room and board. Typically, they go to Surat, Bombay or other big towns in South India where they work in the houses of Marwari (trader) families, a caste with which they have long-standing ties. They return to their villages maybe once a year to visit their families and wives and to become temporarily reabsorbed in their traditional culture.

3. Economic Role of the Camel in India

3.1. Transport Function

In India the camel is used mostly as a draught animal. In the Thar-desert camel carts are still popular and remain a frequent means of transportation. They fulfill this function not only in remote rural areas, but also in the major cities. In Bikaner, but also in Jodhpur and Delhi camel drawn carts are ubiquitous. They move goods of all kinds, especially wood,

fodder, gas cylinders, fabrics, bricks, etc. The typical two-wheeled carts are a relatively recent invention dating back to the 1950s.

Ownership of a camel and a cart is a solid source of income, sufficient to support a family. For this reason, development agencies such as Heifer Project International, but also regional banks support loans for the purchase of a camel cart. According to studies by the National Research Centre on camel, the average daily income from camel carting was Rs. 300/- and Rs. 140/- in city and village areas, respectively, versus a daily expenditure of Rs. 40/camel/day.

The income from camel carting was estimated to be higher in city areas as compared to rural areas because camel keepers of city area were getting more opportunities to transport different agricultural commodities as well as construction material than village area (http://www.icar.org.in/nrccm/bio-main.htm (14.4.04)).

In the hilly parts of the state (Aravalli range and southern Rajasthan), the camel continues to be used as beast of burden, notably for the transportation of harvested crops, such as chili peppers, chara, etc.) It can carry loads weighing 150-300 kg over long distances and 450 kg over short distances. Other chores performed by camels include threshing, lifting of water and powering of oil mills.

The camel is used as riding animals mainly in the Jaisalmer area where it exerts considerable draw on tourists. This is utilized by the Department of Tourism which organizes a Camel Festival in Bikaner and promotes other camel games, such as racing and polo at other festivals.

Finally, the camel also maintains some military significance, being used to patrol the desert border. The Border Security Force keeps 1750 camels for this purpose in Rajasthan and Gujarat.

3.2. Camel Milk

Camel milk is a by-product of camel breeding which is consumed primarily by herdsmen (especially on migration) and by their families. Traditionally there are cultural restrictions on the sale of camel milk and it is not sold in the core camel breeding areas, such as Bikaner, Jodhpur and Jailsamer. But in the late 1990s, there was a large “grey” camel market in the northern tip of Madhya Pradesh and in parts of southern Rajasthan (Bhilwara, Chittorgarh, Udaipur) which proceeded at tea-stalls, to private households, or under the guise of cow/buffalo milk to dairies.

3.3. Camel Meat

Camels are generally not slaughtered in India and the consumption of camel meat is not acceptable to most castes. An exception is the tradition in a few cities with large Muslim populations of sacrificing a camel at the occasion of important Muslim holidays. Within Rajasthan, eating of camel meat is therefore restricted to rare occasions and religious minorities.

However, since the last couple of years, an increasing number of camels is leaving the state to be sold for slaughter in other parts of India, especially West Bengal, but also Bangladesh and purportedly for export to the Middle East. Several thousand of camels, mostly females were sold for this purpose at the Pushkar Fair in 2002 and 2003.

3.4. Camel Wool

Camel wool is used mostly utilized by camel breeders for the manufacture of items to be used in their own household such as rugs, blankets, charpoys and saddle girths. Similarly to camel milk, there also seem to be certain cultural restrictions on the sale of wool.

3.5. Camel Leather

The skins of camels are especially useful for manufacturing lampshades, toys, drum covers and certain types of containers. A regional specialty used to be the kuppa or kuppi, painted vessels for oil, ghee and perfume painted in an intricate pattern. Because of lack of demand this artisan industry has now stopped.

3.6. Camel Bones

Similar to the bones of other animals, camel bones are processed into fertilizer (bone meal). They are also used as in lieu of ivory for the production of jewelry and ornaments.

3.7. Camel Dung

Camel dung represents an important fertilizer and plays an important role in the relationship between camel breeders and farmers. Although the fertilizing effect of camel dung is not as high as that of goat or sheep dung, it is regarded as better than cow dung. Although its effect is retarded, since it takes longer for camel dung to decompose, it lasts for three years. Sedentary camel breeders sell or exchange (for grain) camel dung by the cart load. Nomadic camel pastoralists receive compensation in kind from the owners of the land on which their herds stay over night.

Even higher fertilizing value is attributed to camel urine.

4. Approaches to Supporting Camel Based Livelihoods

Lokhit Pashu-Palak Sansthan, an Indian NGO, has been working with the Raika camel breeding caste since 1996, helping them to improve economic returns from their hereditary activity, by providing camel health care, assistance with camel milk marketing and other support.

The work of LPPS developed out of a research project on the socioeconomics of camel husbandry in India begun in 1990/91. At that time, the Raika from Pali district in central Rajasthan had expressed concern and complaints about the disease problems of their camel herds, mostly early and late miscarriages, as well as difficulties of finding grazing for them. These interactions resulted in an applied research project seeking to verify the information provided by the Raika, to establish data on the reproductive performance of camels under field conditions and to identify the bottle-necks in the system. The research focused on an area known as Godwar which extends along the Aravalli Hills that dissects Rajasthan from Northeast to southwest, but it also encompassed adjacent parts of Pali district. Some of the salient results are summarised here.

5. Results of Applied Research

5.1. The Production System and Yearly Cycle

The Godwar camel breeders are sedentary and engage in village based herding. The herds of the Maru Raikas from outside Godwar are usually migratory and rarely return to the village. Of 156 herds encountered during the project's survey of camel holding families in southern Pali district, 34 or 21.8% were sedentary and 122 or 78.2% were nomadic.

Often 2-5 families form herding groups. The herds are grazed on various types of lands, including fallow or harvested fields, *gocher* (village grazing grounds), *oran* (pasture land devoted to a deity), so-called "wastelands" (uncultivated land under the jurisdiction of the state) and, during the rainy season, the forests of the Aravalli Hills. For access to the latter grazing taxes have to be paid frequently incremented with bribes for the forest officials.

The breeding season falls in the cold months of the year from November to March/April. This is the most work intensive part of the year. During the rainy season from July to October, the incidence of disease is greatest. In November, the calves born during the previous winter are taken for sale to the Pushkar market, a trek that takes some 10-14 days. Traditionally, this is the time when the whole year's income is realized.

5.2. Herd Sizes in Pali District

Herd sizes range between two and 60 head with holdings of 11-20 camels forming the most frequent category.

Herdsize	1-10	11-20	21-30	31-40	41-50	51-60
Number	15	25	17	8	3	1

There was a definite trend for herds to become smaller. Of the 156 camel holdings surveyed in Godwar and adjoining area, 119 (76.3%) were said to have decreased in size over the last 20 years; only 28 (17.9%) had increased, whereas 9 (5.8%) were said to have remained about the same by their owners.

5.3. Income from Camel Breeding[1]

The Raikas predominantly sell young male camels which represent about 2/3s of the sold animals. About 25% of the sold camels are young female animals. The rest are adult animals; either female camels that can not be used for breeding, or male riding or breeding camels.

In 1994, the average price of 67 camels sold by Jojawar Raikas at Pushkar amounted to 2104 Rupees; male animals obtained an average price of 2071 Rupees, compared with 1661 Rupees for females.

In 1995, prices were slightly higher, with 2209 Rupees for male and 1700 Rupees for female young animals. By some this development was attributed to the project inputs.

In 1996, prices were not recorded, but the Pushkar Fair witnessed a dramatic rise in prices for good quality camels which were also so much in demand that after the first two days practically all of them were sold.

The price range for calves of weaning age reportedly runs from a few hundred to around 10,000 Rupees. Camel breeders from other parts of Rajasthan where camels can range unsupervised generally prefer to sell them at the age of 4-5 years when they fetch the highest prices - of up to 20,000 Rupees.

5.4. Profits

The average annual income of the "average" family can be calculated as follows. In an average family holding of 13 female breeding camels, 6-7 calves are born of which 50% (3-4)

[1] The figures presented here are based on an analysis of the total sales made by Raikas from Jojawar at the Pushkar fair. Because the Godwar raikas are selling to traders and middlemen, it was not possible to collect the corresponding information from them.

are male and can be sold. At an average price of 2200 Rupees this amounts to an annual income of 6600-8000 Rupees.

5.5. Disease Spectrum

The two infectious diseases of greatest economic importance are trypanosomiasis and mange.

Other health problems with significant impact include injuries which are often due to falls. Apparently camels fairly often slip or fall down, especially when grazing in the Aravalli Hills. Fractures occur in both young and adult animals. Poisonings from eating certain plants (Lantana sp., Oleander) also occur regularly.

5.6. Calf Diseases

The mortality of young camels is fairly low. Of 47 camel calves whose births were recorded by the project in 1994/95, five died before weaning, i.e. before they could be sold at Pushkar, amounting to an infant mortality rate of 10.6%. This sample was small, but analysis of 388 births with the help of the "progeny history method" also showed that 43 (10.9)% had resulted in infant death.

Of 40 camel calves born to Godwar Raikas in 1995/96 only 2, equivalent to 5%, died before weaning. Causes of death are constipation, diarrhoea and accidents (for instance falling into the well), sometimes also predators (leopards).

5.7. Abortions

An analysis of 473 pregnancies compiled by the Progeny History Method showed that 18% had ended in abortions. The Raika generally attributed the abortions to infection with trypanosomose, although causal connection was never confirmed scientifically.

6. Project Interventions

Based on the results of the research and suggestions of the Raika, the project undertook a number of inventions aimed at making camel breeding more economically viable. These included:

- *Camel health services*, notably prophylactic treatment against trypanosomose and curative treatment for mange
- *Support for camel milk marketing.* In order to generate additional income, the project supported the initiation of camel milk marketing which was against traditional social rules of the Raika community. Depending on the situation of the family (sedentary or nomadic), this can be reasonably profitable, although it requires skilled management if malnourishment of the calves is to be avoided.

LPPS also challenged a ruling of the Rajasthan High Court that had declared camel milk as hazardous for human health and sentenced a Raika camel milk vendor into jail. The Supreme Court in Delhi reversed the judgement and accepted camel milk as fit for human consumption.

- *Provision of superior male breeding camels.* Because the price of camel calves depends very much on their quality, high quality male camels were made available for shared use by the community.

- *Exposure Tours for camel breeders* and linkage with National Research Centre on Camel.
- *Solution of grazing conflicts.* The most important but also the most difficult aspect of the efforts has been pushing for access to grazing in the Aravalli Hills which constitute the traditional summer grazing grounds of the camel herds, and fighting the corruption of the Forest Department. While there have been some successes these have been temporary, and there are plans to further restrict the access of camels to this area. Lack of grazing areas is actually the most crucial and limiting factor to camel breeding.

7. Latest Developments

In 2002 and 2003, thousands of camels were openly sold for meat during the Pushkar camel market. The majority of them were female, and many of them originated from Southern Rajasthan. Some of the traders even boasted that within five years no camels would be left in Rajasthan.

In early 2004, LPPS repeated the survey of camel breeding households that had been conducted in 1995. In one sub-district outside the project area, the number of camels had decreased by exactly 50%. The results of the survey in the project area are still being compiled. But it is obvious that camel breeding is a dieing profession; and that we are now witnessing the last generation. There are a very small handful of young people who are dedicated to camels. In order to encourage them, LPPS, in March 2004, organised a camel race and several other camel competitions which met with enthusiastic response.

8. Conclusions

Despite all its ecological advantages, the camel will continue to loose importance, unless camel breeding is profitable enough to sustain livelihoods. The experiences of LPPS also demonstrate that local activities are not enough and can not really stop the decrease and gradual extinction of the camel, unless the government also provides a supportive policy framework. Most importantly, adequate grazing areas have to be made available. If there are sanctuaries for wildlife, why can there not be some reserved grazing areas for camels? The camel represents something of an orphan commodity that neither animal scientists/Veterinarians feel responsible nor the conservationists. This situation has to change.

Table 1. Camel population trend in Asia (according to FAO data).

Country	Population (1993)	Population (2003)	Change
China	401,000	264,000	-34.2%
India	1,030,000	900,000	-12.6%
Kazakhstan	148,800	108,000	-27.0%
Kyrgyzstan	50,000	46,000	-8.0%
Mongolia	415,200	352,000	-15.2%
Pakistan	1,097,000	800,000	-27.1%
Tajikistan	50,000	42,000	-16.0%
Turkmenistan	40,000	40,000	-
Uzbekistan	23,000	25,000	+8.0%

Furthermore, the stigma that has come to be associated with camel breeding as a backward activity has to be removed. Unless young people perceive camel breeding as a livelihood option that generates a certain minimum income, there is no way that the camel can be saved, except in a zoo.

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The Current Status of the Wild Bactrian Camel

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Abstract. The wild Bactrian camel is found in the Gobi and Gashun Gobi deserts of North West China and Mongolia. While vegetation is sparse, the desert itself varies from rocky mountain massifs, to the flat pavement-like areas of the extremely arid desert; stony "gobi" desert plains; poplar fringed oases; vast washed-out plains and high sand dunes. For 45 years, this area of the Gashun Gobi was the nuclear test site area of China. In spite of this, the Wild Bactrian Camel survived and is apparently breeding naturally. In some areas in the absence of fresh water, it has adapted to drinking salt water slush.

The wild Bactrian Camel is facing a population size reduction of 80% within the next three generations. This projection is based on observations made during five expeditions (1993 - Mongolian Gobi and 1995, 1996, 1997, 1999 - Chinese Gobi). The population is the target of continued hunting. Suitable habitat in China (the main stronghold for the species) is being lost through illegal mining. The proposed construction of a gas pipeline and the associated industrial development will also have a major impact on the main Chinese subpopulation of Wild Bactrian Camel and its desert eco-system. The effects of hybridisation with domestic camels both in Mongolia and China and increased human competition and economic pressures within the designated desert habitat of the wild Bactrian camel, have also contributed to its decline. The Mongolian subpopulation is known to have declined by 46% since 1985. However, due to increased hunting and wolf predation it is now expected that 25-30 animals will be lost annually. Based on these observations, it is estimated that there will be at least an 84% reduction in the population size by the least 20 animals are killed annually) there is no reason to expect the situation for these subpopulations to be any different.

The wild Bactrian camel, the remarkable ancestor of domestic camels, lives in three separated habitats in North West China and one in Mongolia. The majority lives in the parched and uninhabited Gashun Gobi (Lop Nur) desert in the south eastern Xinjiang Uighur Autonomous Region. The only other place they still survive is the Gobi Desert in the south west of Mongolia. There are approximately 600 individuals surviving in China and 350 in Mongolia. Their numbers are decreasing each year. In 1985 the Mongolian subpopulation numbered 650 animals.

Found in the Gobi and Gashun Gobi deserts of North West China and Mongolia. While vegetation is sparse, the desert itself varies from rocky mountain massifs, to the flat pavement-like areas of the extremely arid desert; stony "gobi" desert plains; poplar fringed oases; vast washed-out plains and high sand dunes. For 45 years, this area of the Gashun Gobi was the nuclear test site area of China. In spite of this, the wild Bactrian camel survived and is apparently breeding naturally. In some areas in the absence of fresh water, it has adapted to drinking salt water slush which the domestic camel will not touch.

The wild Bactrian camel is facing a population size reduction of at least 80% within the next three generations. This projection is based on observations made during five expedi-

tions (1993 - Mongolian Gobi and 1995, 1996, 1997, 1999 - Chinese Gobi). The population is the target of continued hunting (mainly persecution because the camels compete with domestic camels and livestock for water and grazing, but also sport hunting). Suitable habitat in China (the main stronghold for the species) is being lost through illegal mining. The construction of a gas pipeline and the associated industrial development will also have a major impact on the main Chinese subpopulation of wild Bactrian camel. The effects of hybridisation with domestic camels both in Mongolia and China and increased human competition and economic pressures within the designated habitat of the wild Bactrian camel, have prompted the listing with the International Union for the Conservation of Nature (IUCN) as 'critically endangered'.

The Mongolian subpopulation is known to have declined by 46% since 1985. However, due to increased hunting and wolf predation it is now expected that 25-30 animals will be lost annually from this subpopulation (a substantial increase in the mortality rate). Based on these observations and assuming that the trends will continue into the future, it is estimated that there will be at least an 84% reduction in the population size by the year 2033 (approximately three generations from 1985). Given the increasing threats to the Chinese subpopulations (where at least 20 animals are killed annually) there is no reason to expect the situation for these subpopulations to be any different. Due to the reduction in water points (oases) because of drought, wolves have increased their predation of wild Bactrian Camels. This activity is concentrated at the remaining water points in the area. The remaining habitat in Mongolia is also being degraded by domestic livestock.

It is estimated from information received from the Protected Area staff and Mongolian scientists working in the Great Gobi Reserve A that in Mongolia, 25-30 wild Bactrian Camels are being killed annually when they migrate across the international border into China on the southernmost boundary of the protected area Great Gobi Reserve A.

In China in the new Arjin Shan Lop Nur Nature Sanctuary, up to 20 wild Bactrian Camels are being shot annually by miners and hunters. Economic pressure to use the areas adjoining the Nature Reserve as grazing for domestic Bactrian camels has increased hybridisation on the southern border and this poses a significant threat to the unique genetic strain of the wild Bactrian camel which current scientific DNA research suggests might be a separate species.

Since the cessation of nuclear tests in China, the wild Bactrian Camel now faces new threats including highly toxic illegal mining and hunting for food and sport. Parts of the wild Bactrian camel's designated habitat are likely to be designated for industrial use (gas pipe line laying, exploitation of minerals). Domestic Bactrian camels and goats have also been introduced to the designated areas and hence compete for grazing and water.

Conservation Measures

The 'Great Gobi Reserve A' was established in Mongolia in 1982 and in 2000, the 'Arjin Shan Lop Nur Nature Reserve' was established in China through the efforts of the wild Camel Protection Foundation (WCPF). Although the first phase of Nature Reserve construction is now complete, much more work, including the opening of a second Nature Reserve in China is needed.

The establishment of a captive wild Bactrian camel breeding programme in Mongolia has been initiated by the WCPF. This is an urgent conservation priority. Only fifteen wild Bactrian camels are currently in captivity in China and Mongolia. With so few captive animals, the whole species could be wiped out if their natural habitats in China and Mongolia are destroyed. It is therefore important to breed enough animals in captivity to insure against this possible disaster. As each female camel can have young at most once every two years, relying on natural methods would permit the numbers to rise very slowly. In view of

this, embryo transfer techniques are under consideration. The breeding site has been given to the WCPF by the Mongolian government, staff has been appointed and a protective fence erected. The wild camels are currently being genetically tested and the conservation programme is rapidly advancing.

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Environmental Education and Public Awareness: Valuable Tools in Combating Desertification

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Abstract. The Wild Camel Protection Foundation, as part of it work to save the wild Bactrian camel, and its unique habitat has started with the full support and co-operation of the Chinese and Mongolian governments, a multi language environmental education and public awareness programme in north west China and Mongolia. The plan is to produce a series of booklets which can be used in the local, national and regional environmental programmes in these two countries. Where possible these materials will be used in schools and for teaching teachers. To date two booklets have been produced one on the wild Bactrian camel, "The King of the Gobi" and the second on "Desertification". We are currently preparing the 2nd and 3rd booklets.

While main aim of the programme is to disseminate environmental information, some of the other aims are to raise awareness in the local population of important environmental issues relating to water and desertification; involve the local population in, and, obtain their support for, the protection of the biodiversity of the nature reserves and protected areas and develop mechanisms for exchanging environmental information

The Wild Camel Protection Foundation, was established in the United Kingdom in 1996 as an environmental charity with the sole aim of protecting the critically endangered wild bactrian camel (*Camelus batrianus ferus*) in its natural environment in China and Mongolia. This environment is desert, part of the Great Gobi Desert, the great stony desert of North Central Asia covering an area which runs in an East-West direction across Southern Mongolia and Northern China, from the Da Hinggan (Great Khingan) mountains to the Tian Shan. It is one of the world's largest deserts. Situated on a plateau which has an average height of between 3,000 and 5,000 feet (910 -1,520 meters) it is made up of a series of shallow alkaline basins. Situated deep within the continental interior of the Asian continent and far from moisture laden winds.

Precipitation occurs rarely, once every two to three years and averages less than 100mm annually. The winters are very cold and the summers short and hot. The climate is extreme, temperatures rise to 40 degrees Celsius in the summer and fall to -40 degrees Celsius in the winter. The Great Gobi Desert is one of the greatest deserts in the world, and with its variation of desert types it is unique in Asia.

While vegetation is sparse, the desert itself varies from rocky mountain massifs to the flat pavement-like areas of extremely arid desert; stony "Gobi" desert plains; poplar fringed

oases; vast washed-out plains and high sand dunes. Ancient fossils show that the Great Gobi Desert was once part of a large inland sea basin.

It is of world wide importance as a region of unique desert landscapes with special fauna and flora. It is still possible to find representatives of the ancient surface fauna of Central Asia, the wild Bactrian camel (*Camelus bactrianus ferus*), Gobi bear (*Ursus arctos*), wild Argali sheep (*Ovis ammon*), the Wild Ass (Khulan) (*Equus hemionus*) and the Black-tailed gazelle (*Gazella subgutturosa*). All these species are listed in the Convention on International Trade in Endangered Species (CITES) and the Red Book's of both China and Mongolia. Although a natural desert the actions of man, land degradation, water overuse and over stocking and over grazing by domestic animals are increasing yearly the area of desert in north west China. This problem of Desertification is a man made problem and requires the involvement of communities at a local, regional and national level in both countries if the process of Desertification is to be stopped.

The Wild Camel Protection Foundation building on its success with the State Environment Protection Administration (SEPA) in China and the Xinjiang Environmental Protection Bureau (XEPB) in establishing a national nature reserve in this area is aware that for the long term sustainable success of this project, protecting the wild Bactrian camel and its desert habitat local people should be involved not only in the protection but also learn and understand the reason for the establishment of the protected area. This can only be done through public awareness an understanding that the protected area and the endangered flora and fauna belong to them. These values of stewardship and protection of nature and not destroying the natural environment come mainly through environmental education programmes, and environmental public awareness campaigns.

WCPF has started with the full support and co-operation of the Chinese and Mongolian governments, a multi language (Chinese, Mongolian, Uighur, Kazakh and English) environmental education and public awareness programme in North West China and Mongolia. The plan is to produce a series of booklets which can be used in the local, national and regional environmental programmes in these two countries. Where possible these materials will be used in schools and for teaching teachers.

So far three booklets have been produced one on the wild Bactrian camel, “The King of the Gobi” the second on “Desertification” and third on the rare and medicinal Gobi Plants. We are currently preparing the 4th booklets.

We have also prepared posters, multi language videos for dissemination amongst communities local to the Nature Reserve in China and the protected area in Mongolia. We work closely with the reserve and protected area staff, many of whom are recruited from the local communities. They are trained and then work with the communities organising local environmental programmes and raising awareness and understanding in the local communities of the reason for the protected area and the importance of their involvement in ensuring these areas continue to be protected.

Illegal hunting of the wild Bactrian camel inside the Chinese Nature Reserve and overgrazing by local goat and sheep herders within the boundary areas are problems which involve the local communities. Without their support these problems cannot be solved.

While the main aim of the education programme is to disseminate environmental information, at a local regional and national level in China and Mongolia, some of the other aims are to raise awareness in the local population of important environmental issues relating to water use; desertification; obtain their support for, the protection of the biodiversity of the nature reserves and protected areas; and develop mechanisms for exchanging environmental information between the protected areas in China and Mongolia.

These desert areas in both China and Mongolia are also rich in natural resources, oil, gold and gas. Therefore there are national and international problems which have to be addressed. WCPF in China has tried to raise awareness at a national level, providing informa-

tion about this critically endangered animal and its unique desert habitat to Chinese national television and media. The wild Bactrian camel is more endangered than the giant panda and because it requires a large habitat, the wild Bactrian camel can also act as an "umbrella species", affording protection with its requirements for a large habitat area to a large number and variety of other endangered flora and fauna.

WCPF also works at an international level to raise awareness of all these issues in China and Mongolia and an understanding of the global importance of protecting the wild Bactrian camel and its habitat.

WCPF is also working closely with the Jane Goodall Roots and Shoots China programme which teaches, teachers, to teach children about the environment. All our publications and materials are included in their teacher training packs.

For further information please look at our website www.wildcamels.com or write to us at Wild Camel Protection Foundation School Farm Benenden, Kent England TN17 4EU.

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Desertification and Camel-Breeding in Kalmykia (Russian Federation)

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Abstract. Traditional stockbreeding affecting minimally fragile arid pastures is one of the methods to combat desertification. The camel (*Camelus*) is one of the best-fit species for arid regions. There is no other species, which is so biologically adapted to the conditions of deserts and semi deserts than the camel. This adaptability to arid environment is determined by their specific morphology, physiology, anatomy and ecology. It exceeds other domestic animals in producing foodstuffs, at the same time affecting the arid pastures minimally. Therefore the unique characteristics of this animal are of great economic interest.

Camel-breeding is one of the most ancient ways of stock-breeding. However currently it experiences serious drawbacks in the world and Russia as well. It was stressed at the UNEP international conference in Kenya (1986) that, 'in arid pastures camels play an important role in facilitating the environmental protection and restoration of degraded lands, and also contributing to human adaptability to the desert'.

In the Russian Federation camels are raised in the republic of Tyva and Kalmykia, in the Altai Krai, Volgograd, Astrakhan and Saratov regions. About 40% of the stock are two-humped camels (*Camelus Bactrianus*), raised in the Republic of Kalmykia, Astrakhan, Volgograd and Saratov regions.

Bactrians are represented by the three separate breeds: Kalmyk, Kazakh and Mongolian. According to experts' estimates the most valuable yet not numerous are Kalmyk bactrians. This species was introduced to Russia early in the 17th century during the Kalmyk migration from western Dzungaria to the right bank of the Volga river, which is now the territory of modern republic of Kalmykia and Astrakhan region.

Republic of Kalmykia is characterized by recent catastrophic degradation of natural pastures. This deterioration of ecological situation in the republic can be accounted for gradual decline of the traditional for the region stockbreeding (horse-, camel- and coarse-fleeced sheep breeding), which was replaced by fine-fleeced sheep-breeding. Currently the population of Kalmyk Bactrian in the republic is no more than 500 animals.

Severe continental climatic conditions favor the raising of Kamyk Bactrian with their unique biological and productive qualities. This will contribute to some extent to the improvement of the situation and optimization of the natural resources in semi-deserts and deserts.

Camel-breeding is one of the approaches for agricultural development of the deserts, semi-deserts and arid steppes occupying the territory of Kalmykia and vast regions of the south-eastern part of the European Russia.

From the second half of the last century the ecosystems of the Russian Federation have been subjected to the strong anthropogenis pressure aggravated by natural factors. Increased arable areas, rise in livestock and intensive fodder lying-in resulted in dramatic destruction of the environment and resource equilibrium and increase of the desertified arid

Table 1. Geography of the desertification forms in the Russian Caspian region (NPDBO, VNIALMI, 1999).

Administrative territory	Desertification form and area, 1000 ha / %			
	salinization	deflation	erosion	total
Dagestan	1303,1 80,7	203,5 12,6	107,5 6,7	1614,1
Kalmykia	2377,2 53,3	1758,4 39,4	326,9 7,3	4462,5
Stavropol territory	376,1 56,1	245,5 36,5	49,4 7,4	670,5
Astrakhan region	664,6 68,8	300,1 31,1	0,7 0,1	965,4
Volgograd region	700,7 42,8	41,6 2,5	895,4 54,7	1637,7
Rostov region	79,3 16,2	120,1 24,5	289,9 59,3	489,3
Region	5501,0 59,9	2668,7 27,1	1669,8 17,0	9839,5 100,0

territories. According to the UNO Convention on the Desertification Combat (Geneva, 1995), this means land deterioration in the arid, semi-arid and dry sub humid regions affected by different factors, including climatic changes and anthropogenic activities.

If in 1994-96 there were 17 regions in the Russian Federation affected by desertification process, in 1999 their number increased to 28 regions according to I.S.Zonn and G.S.Kust, in 2000 the Ministry for Natural Resources of the Russian Federation registered 35 regions subject to desertification and potentially vulnerable to the process. Especially affected were the Caspian pastures (Dagestan, Kalmykia, Astrakhan region and Volgograd, eastern parts of the Rostov territory and Stavropol), occupying about 12.6 millions hectares.

The Caspian region can serve as a typical arid belt of Russia in many ways. This territory contains all the natural-climatic zones, included by UNESCO (1977) into the arid territories: steppe (5.44 millions ha), arid steppe (13.67 millions ha), semi-desert (6,39 millions ha) and desert (5,66 millions ha) (Table 1).

Such adverse processes (including the negative consequences of the human activity and settling patterns) as wind and water land erosion, deterioration of physical, chemical, biological and economic characteristics of the soils, long-term loss of natural vegetation cover are characteristic practically of all the above-mentioned territories of the Russian Federation.

The main reasons for such situation in the arid regions of Russia are unsustainable land use, destruction of natural landscapes, and recent shortage of financing and subsidizing of the projects to combat desertification and also global warming.

The problem of desertification is complex and is related not only to ecological, but also to economic and social reasons and mostly with land deterioration, reduction and loss of its biological and economic productivity. As a result of desertification processes in arid regions of the Russian Federation, social, economic and demographic issues also became very acute, environmental situation is getting aggravated; these problems need to be addressed immediately with the application of diverse methods to combat desertification.

In its scale, escalation and gravity the speed of desertification of the Black soils region and Kizlyar pastures is unprecedented for Russia and Europe in the whole. Thus, over the period of 1976-1986, 1 million ha of land got deteriorated and 25 settlements were eliminated from the map of Kalmykia.

The Black Soils (Chernye zemli) can serve as a classical example of the anthropogenic desertification in the Republic of Kalmykia. The total area of the Black Soils region is

3619,6 ha, including 2,994 ths ha (82,7%) within the Kalmyk borders, 235,6 ths ha (6,5%) of the Republic of Dagestan, 390 ths ha (10,8%) of the Astrakhan region.

The current environmental crisis and the anthropogenic desertification of the Black Soils can be accounted for unreasonable raising of sheep stock, change from a century-long pattern of stock-breeding and seasonal use of the pastures to all-year-round overgrazing, all these resulted in heaviest load to the pastures, ploughing of low-grass (desert) steppes, including sand soils.

The desertification problem can be approached in two ways: pasture rotation and phytomelioration. Moreover the traditional methods, such as raising of the cattle, which would minimally affect arid pastures, also play an important role in the preservation of arid ecosystems and desertification combat.

One of the species most adjusted to the arid environmental conditions is camel (Camelus). There are two subspecies – Bactrian or two-humped camel (C. b*actrianus*) and dromedary or one-humped camel (C.d*romedarius*).

At the UNEP International workshop in Wambe (Kenya, May 1986) it was stressed that, "camels contribute significantly to the adaptation of the people to the desert conditions and are related to the issue of rehabilitation of degraded lands and environment".

There is no other animal so biologically adapted to deserts and semi-deserts as camel. During many centuries it has been and even now in the epoch of science and technology is serving as a link between man and desert.

This adaptability of camels to arid environment can be accounted for its specific morphology, physiology, anatomy and ecology. Therefore, in the arid regions of the Russian Federation more attention should be paid to the unique characteristics of that animal, who exceeds other domestic animals in food products output at the same time minimally affecting the pastures in arid regions.

Camel-breeding is one of the most ancient types of stock-raising. The earliest data on wild camels are to be found in Chinese sources. First references to two-humped camel in western parts of China are found in Chinese chronicles in 1000 BC. It is highly possible that the habitat of wild two-humped camel then was considerably larger than that of today. The Romans called two-humped camel Bactrian after the ancient country of Bactrian (Middle Asia), therefore domestication of two-humped animals took place no lesser than 1000 BC in the Central and probably Middle Asia.

Currently the development of camel-breeding in the world and in Russia is hampered. In the regions with developed economy and industry, high level of mechanization and transportation in agriculture, the significance of camels and therefore their stock is decreasing.

A considerable drawback of camel-breeding in Russia is the fact that it is not given due importance and also the share of produce coming camel-breeding is not taken into consideration in the economy of the arid regions. Having increased the stock of camels on the vast territories under semi deserts and deserts, we could get significant output of cheap competitive camel products: meat, wool, milk and leather.

In the Russian Federation camel-breeding is spread in the Republic of Tyva, Kalmykia, Altai territory, in the regions of Volgograd, Astrakhan and Saratov. About 40% of the whole stock is made up by two-humped camels (*Camelus Bactrianus*), which are raised in Kalmykia, Astrakhan, Volgograd and Saratov regions. These territories with all-the-year-round pastures including those of the Black soils area of Kalmykia, with mild climate and abundant forage turned to be favorable not only for maintaining breed qualities but also productive qualities of camel.

Breeding of camels with their unique biological and productive characteristics enable us to use natural resources of deserts and semi-deserts more sustainable and produce additional quality of milk, meat, wool under progressive desertification. Due to the fact that

Table 2. Domestic animals produce.

Type of domestic animal	Produce				
	labor	Wool	milk	meat	fat
Camel	+	+	+	+	+
Horse	+	-	+	+	-
Sheep	-	+	+	+	-
Cattle	+	-	+	+	-
Pig	-	-	-	+	+

Table 3. Comparative survey of 15-month-old male camels.

Camel species	Live weight (kg)	height	body length	Chest span	Mouth (jaws) circumference
Bactrians	390	157	128	182	20
Dromedars	310	156	121	166	18

Table 4. Chemical composition of camel's milk.

Camel species	Pomace, %	Fat, %	Casein, %	Albumin, %	Ashes, %	Sugar, %	Thickness
Bactrians	14,88	5,30	2,90	0,97	0,69	5,10	1,033
Dromedars	13,64	4,47	2,70	0,89	0,70	4,95	1,032

camels graze the whole year round, the costs of their upkeep are not big. Therefore, camel breeding as a source of milk, meat and wool can be considered as one of the most efficient sectors of pasture stock-raising, since the cost per unit of gross output is less in comparison to other sectors of branch stock-raising.

Among the domestic animals camel exceeds in its life span (35-40 years). It is also unique in the character of its output. The camel output formula is as follows: labor – wool – milk – meat – fat. No other domestic animal can be described as having such a wide range of produce (Table 2).

Bactrians and dromedaries differ considerably both in their size (Table 3) and productivity.

Camel's milk is highly valued in all the regions where they raise Bactrians and dromedaries. It is close to cow's milk in protein and sugar and exceeds in their content mare's milk. The chemical composition of the camels' milk is shown in table 4.

Camel's milk and other dairy products contain all types of amino acids, vitamins A, C and B, therefore they are used to cure various pneumatic and digestive diseases. Generally, a so-called 'shubat' or camel's koumiss is consumed. The main hindrance in development of camel's dairy in Kalmykia, and in Russia is weak marketability of the product due to the absence of the special methods of processing and transporting of the camel's milk.

Bactrians are represented by the 3 separate subspecies – Kalmyk, Kazakh, and Mongol. According to the specialists estimates Kalmyk species is the most valuable yet not numerous. Kalmyk bactrians are 7,5 cm higher than Kazakh and 13,7 cm than Mongols, they are 50 kg heavier than Kazakh and 150 kg heavier than Mongol camels. This species was introduced to Russia early in the 17th century, when the Kalmyks migrated from the Western Djungariya to the right bank of the river Volga, where the modern republic of Kalmykia and Astrakhan region are located.

Since ancient times the territory of Kalmykia was the region for nomadic economy for many peoples, and since the 16th century it was the homeland for the Kalmyk cattle-breeders. Over several centuries natural resources were used mainly for sheep-breeding,

Table 5. Qualities of camel meat, Kalmyk breed (Yusta region, Republic of Kalmykia).

Males/females	Live weight, kg	Output, kg			Dead-weight
		Meat	Fat	Meat +Fat	
Males	687	332	80	412	60
Females	553	247	73	320	58

camel-breeding, horse- and cattle-breeding, i.e. stock-breeding. Historically, Kalmyks were nomadic cattle-breeders. The ancient breeders knew, that the land has its own laws, which are to be observed to keep up the balance with the nature. Such type of the economy enabled the Kalmyks to provide themselves with all sorts of dairy products without damaging the land.

Thus, in 1913 the population of Kalmykia was about 300 000 people, and on the pastures there were about 1 million sheep, almost 200 000 horses, 300 000 cattle and 20 000 camels. Such proportion of different animals seems to be optimal since in this case the pastures are utilized sustainably. Till the 1920s dry steppes of Kalmykia preserved their diverse wildlife in their primeval beauty.

Severe conditions of the sharply-continental climate created large sturdy animals. The Kalmyk species of camels can be differentiated among 3 subtypes: heavy-weighted, typical, and light-weighted. This differentiation contributes to the further improvement of breed and productive qualities of the animals. For instance, heavy-weighted type is advisable for meat production. With the right management of the pedigree activities and research-based pasturing such animals could yield much cheap meat produce.

In the recent decades of the last century Kalmykia had increased the share of cattle and at the same time decreased the number of camels in the livestock. This process was characteristic not only for Kalmykia, but also for all the nomadic cattle-breeding peoples of Russia, who transferred to a semi-settled life. Thus, in 1803 in Kalmykia there were 60,452 camels, in 1909 the number decreased to 26,288 animals, in 1941 there were 4,500 heads, in 1996 – about 1,000 animals, in 1995 – 400 heads, in 1998 – 500 heads, in 2000 – 250 heads, in 2003 – 350 heads.

The Republic of Kalmykia is characterized by a dramatic deterioration of natural pastures. This gradual ousting and narrowing down of the typical-for-the-region cattle-breeding (horse-, camel- and coarse fleeced sheep-breeding) and replacement by fine-fleeced sheep species contributed to the aggravation of the ecological situation in the republic. The experience is that the pasture overload by fine-fleeced sheep and cattle resulted in degraded poor botanic composition, decreased land productivity, which showed negatively in the state of the stock-breeding in the whole.

Although the severe conditions of the sharply-continental climate in Kalmykia are very favorable for the breeding of camels. Unfortunately, currently in the republic the number of the Kalmyk bactrians does not exceed 500 animals while in the neighboring Astrakhan region there are more than 7000 Kalmyk Bactrians.

There is only one camel-breeding farm in Kalmykia (Polynnii village, Yusta region), where 90% of the republic stock is held. During several decades in this farm they have been conducting research on meat, milk and wool productivity of the Kalmyk Bactrians. Thus, meat productivity of the camels is estimated by the precocity degree, rate of fattening, nourishing qualities, live weight, and dead-weight (Table 5).

The young of camels weigh about 49 kg at birth, during their first year their weight increases more than three times, average daily increase being 600-650 gr, and at the age of 30 months their weight makes 80% of the live-weight of an adult animal.

Kalmyk Bactrians have an extremely high rate of fattening on natural pastures. According to the latest appraisal in the Polynnii farm, the average live-weight of a dam is 592 kg. The dead-weight of meat-fat produce makes up from 50 to 61% of a grown-up animal.

Table 6. Net output of wool, Kalmyk bactrians.

Sex/age group	Wool type, %	
	soft	mane
Sire	79,1	82,0
Dam	92,6	78,8
Young under 12 months	81,7	78,4

Alongside with milk and meat productivity, camel wool is of special importance, for camel fiber exceeds in durability and quality all the types of sheep wool. The net output of wool from female and male animals of different age is quite high – about 80% and more (Table 6).

Camel wool is utilized in coarse- and thin-clothed production, camel down is used in thin-clothing and knitting. The mane goes to produce driving belts and oil press cloth. The best sires yield 12-13 kg of wool, and dams – 8-9 kg. On average Kalmyk bactrians exceed by the wool yield Kazakh and Mongol camels by 0.5 kg and 0,8 kg relatively.

Selection works together with favorable climatic conditions of the Kalmyk steppes produced large and strong animals. It is put on record that at the agricultural exposition in Moscow in 1939 there were unique Kalmyk bactrians from Chernozemelsk ulus of the Kalmyk ASSR, among them the 9-year-old camel 'Beke-Khar-II' of 1247 kg, and the camel 'Tolga-I' of 1180 kg.

Currently in Kalmykia there are camels of pure bred, because the Kalmyk breed is not numerous and homogeneous in its composition. Previously camels were largely used in agricultural work lately they lost such a role and are mostly utilized for milk, meat and wool/leather industry.

The President of the Republic of Kalmykia in his decree approved of the Conception of accelerated development in the agro-industrial complex in Kalmykia for the period to 2005, and also the special program "On the revival of traditional pasture cattle-raising (2001-2010)", where the top priority is given to cattle-breeding, including camel-breeding. Therefore, alongside with horse-, sheep- and cattle-breeding, camel-breeding should become one of the main sectors of agricultural production. Camel-breeding can contribute to desertification combat, and camels can become the animal of the future, and not of the past.

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Realization of the National Action Program to Combat Desertification in Turkmenistan

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Abstract. Turkmenistan is a mainly desert country (80%). To combat desertification a national programme was set up including research institutes and local decision makers. The German cooperation (GTZ) contributed to the different actions for desert control. The programme includes economic, social and technical aspects.

Owing to its natural conditions which cause a sharply continental climate, Turkmenistan belongs to the zone of Central Asian deserts. The northern part of Turkmenistan is within the area of ecological crisis of Aral Sea region. Therefore, the country is constantly under the influence of the processes of desertification which affects the social-economic sphere of Turkmenistan. Hence, the environmental protection, the rational use of natural resources and the effective utilization of land resources in particular, are the principal issues in the state environmental policy of Turkmenistan.

Besides the natural factor of desertification, an anthropogenic factor directly aggravates the processes of land degradation and manifests the most in livestock-breeding and irrigation farming.

More than 80% of country's territory is occupied by one of the largest desert in world, Karakum Desert, the vegetation cover of which has been serving for centuries as pasture forage and fuel wood. The Karakum Desert covers almost the whole plain territory of Turkmenistan and belongs to sandy type of deserts formed by ancient alluvial sediments which are exposed to deflation processes. The different infrastructure and socio-economic unites are affected by the wind erosion, such as railway, roads, fields, channels, water reservoirs, settlements, pipelines, etc. Control of sand deflation and erosion give possibility to preserve productivity of thousand hectares of land and to run trouble free the important engineering constructions.

Total area of pasture in the country is 41,5 million hectares, out of them 2,5 million hectares is a share of mountainous pastures (6%) and 39 million hectares of desert pastures (94%). Presently, as a result of intensive anthropogenic activity more than 50% of pastures are degraded and 5% is transformed into moving sand.

According to desert types, desert pastures are differentiated by their area as follows:

- Pastures of sandy deserts occupy 26 million hectares with productivity 100-400 kg/ha.
- Pastures of gypsum desert occupy 5 million hectares with productivity 60-280 kg/ha.
- Pastures of clay desert occupy 4 million hectares with productivity 80-400 kg/ha.

- Pastures of foothill-loess desert occupy 4 million hectares with productivity 50-300 kg/ha under annual precipitation of 200mm and 150-600 kg/ha under annual precipitation of 300 mm.

Out of 41,5 million hectares of pastures only 25 million hectares are provided with water sources. The concentration of large amount of livestock around water sources are inevitably leads to severe soil breaking and formation of moving sand. Insufficient water supply resulted in exceeding carrying capacity of pastures. Pasture rotation could help in conservation of pastures vegetation.

Pastures with depleted species composition and reduced productivity require to be excluded from agricultural use for 6-7 years for regeneration. Exclusion from use is not sufficient for severely degraded areas which require intervention by phyto-melioration activities.

Nowadays, theoretical and practical knowledge and technologies to increase productivity of arid pastures by 2-3 times are available. On the base of many years experience the National Institute of Deserts, Flora and Fauna of the Ministry of Environment of Turkmenistan has elaborated technologies for the rehabilitation and improvement of degraded pastures, as well as their rational use.

Irrigation areas have small specific proportion in the structure of land use system, but the areas have been under the big pressure. Extensive use of natural resources since the Soviet period has led to environmental deterioration which is especially acute in agriculture. Relatively cheap and obsolete practice of development of irrigation lands, insufficient provision with drainage network (25-30 meters/hectares against 50-55 meters/hectares) led to the raise of underground water up to 1-2,5 meters from land surface.

At the present time, 30 per cent of irrigated lands are at the stage of severe degradation, 50per cent of land are at the stage of moderate degradation. This caused the reduction of agricultural productivity up to 50per cent. Hence, the complex of measures should be performed in this direction including construction of ramified drainage network.

Degradation and desertification of land are caused by the inappropriate use of chemical fertilizers, pesticides and defoliants, as well as by the irrational water use, the lack of crop rotation, the drainage water, the wide extension of soil with low humus content (about 75per cent of the country's area), the reduction of pastures' productivity, etc.

In connection with above-depicted problems, Turkmenistan has defined the issues of priority in the field of soil conservation as follows:

- Reduction of soil salinity caused by human activities (inadequate irrigation and drainage network, misuse of fertilizers) and natural factors (the impact of Aral Sea).
- Reduction of pasture degradation caused by the human activities (clearing of Halloxilon sp. and other sand-fixing species, industrial development of desert territories, etc) and natural factors (aridity, deflation and soil erosion, etc.).
- Reduction of wind and water erosion.
- Control of the processes deteriorating natural soil layer (land re-cultivation).

The government of the country has been carried out the number of measures aiming at the localization and eradication of violations in the land use and conservation of the land resources. They are:

- Introduction of modern farming system based on the optimal water use.
- Cleaning and construction of new drainage network with outlet for mineralized water from cultural zone to the main drainages.
- Expansion of irrigated areas on the base of scientifically approved crop rotation in order to preserve the natural soil layer.
- Reconstruction and establishment of new forest shield and forestland in order to preserve the soil and accumulate moisture.

- Working out and adaptation of standards for the application of fertilizers and other chemical substances in agriculture.
- Carrying out the measures on land resources conservation and their qualitative improvement by use of the modern technologies of desert land afforestation and change of the structure of agricultural crops.

Paying a special attention to desertification problem, Turkmenistan joined the UN Convention to Combat Desertification in 1996. Next year, the National Action Program to Combat Desertification (NAPCD) was designed. Among the main tasks of NAPCD's realization are:

- Elaboration of the national system of desertification monitoring;
- Rational use and melioration of irrigated lands;
- Rational use and improvement of rangeland;
- Afforestation and rehabilitation of forests;
- Promotion of primary scientific and technical research.

Since the elaboration of the NAPCD, the actions to implements the UNCCD has been carried out and reflected in two national reports (2000, 2002).

In order to coordinate the activities of the ministries and organizations in realization of obligations of Turkmenistan under the regulations of the UN environmental conventions and programs, as well as to enforce the state policy in the field of nature conservation and rational use of natural resources, the State Commission was established by the presidential degree. The State Commission is composed by the representatives of different ministries and organizations.

The National Institute of Deserts, Flora and Fauna of the Ministry of Nature Protection of Turkmenistan is the National Coordinating Center to Combat Desertification in Turkmenistan. In 1997 with the help of the German Agency for Technical Cooperation (GTZ), the Center to Combat Desertification was established on the basis of the National Institute. The Center is equipped with modern computer and communication facilities, GIS software.

Turkmenistan takes active part in elaboration and implementation of the Sub-regional Action Program to Combat Desertification in Central Asia.

In the realization of the UNCCD Turkmenistan closely cooperates with the numbers of international agencies such as, the Secretariat of the UNCCD, Global Mechanism of the UNCCD, German Agency for Technical Cooperation (GTZ), Asian Development Bank, TACIS, UNDP, USAID and others.

Under the UNCCD the number of national and international projects has been carried out in Turkmenistan. In the framework of Caspian Ecological Program with support of TACIS the Caspian Regional Thematic Center on Desertification Combat (CRTC) was established at the NIDFF in Turkmenistan. The major tasks of the Thematic Center are Definition of complex of factors which influence the beginning and development of desertification processes in Caspian region, Assessment of desertification processes in Caspian littoral zone, Elaboration of map of dynamics and risk of desertification, as well as working out the anti-desertification activities.

In 2003, the FAO project "Management of Water and Soil Resources in Irrigation Schemes" commenced in Turkmenistan. Project aims at training the governmental personnel and landusers in assessment of water and soil resources conditions and how to prepare and implement programs on optimization of water use at farm level.

Under USAID program the number of projects studying desertification monitoring, rehabilitation of degraded pastures, water harvesting and halophytes cultivation are being carried out in the NIDFF.

Other example of the realization of the NAPCD is a "Community-based Natural Resources Management" pilot project implemented by the experts of NIDFF with the financial

and technical assistance of GTZ-CCD (Germany). The project started its activities in the village of Bakhardok in the Central Karakum Desert in 1998. In April 2000, project extended its area adding two new pilot regions.

The objectives of the project are: improvement of living conditions of local population by development of self-help potential, introduction of desertification combat methods and their adaptation by the local population, accumulation and exchange of experience on desertification combat at the national and international levels.

The project is being implemented with consultative, financial and technical support of Germany. The representatives of GTZ and German experts visit Turkmenistan regularly to consult on project's activities. The external experts take part in the discussion of socio-economic and ecological problems in the pilot regions and provide with methodological assistance in the organization of the seminars in rural regions and project planning.

Despite, natural conditions and types of occupation of inhabitants of three project regions differ significantly, developing processes of desertification are common for all regions.

The priority activities to combat desertification in the Central Karakum Desert (Yerbent pilot region) are the fixation of moving sand and promotion of private fruit and vegetable growing. The possibility for optimization of extensive livestock-breeding is being studied with the view of pasture improvement. In the villages of Central Kopetdag Mountains (Nohur pilot region) project's experts together with the local inhabitants are looking for solution of water supply, rehabilitation of mountainous forests and soil erosion combat which cause frequent and destructive landslides. In Mary oasis (Sakar-chaga pilot region) ecological problems are closely linked with agriculture. This fact identifies the scope of activities for the project: control of soil salinization and optimization of agricultural practices.

One of the tasks of the project is to identify the supplementary sources of income which can build upon the traditional knowledge of local inhabitants, as well as promotion of alternative sources of income. Establishment of tree nurseries in mountainous village of Garavul and developing greenhouse farming in Sakar-chaga are the example of alternative sources of income.

Management of natural resources and related to this activities are being planned and implemented together with the local population according to their problems, needs and priorities. The dynamics of the project is defined by people themselves.

For the realization of the project's activities on wider scale or for the initiation of new activities, the experts of the project use different methods, for example, expanding the activities from one "target village" to the neighboring villages upon the request of their inhabitants. This can only become possible thank to official and casual meetings with participation of inhabitants of the villages where project carries out its activities, neighboring villages, local administration and external experts. The meetings are hold in order to discuss the on-going activities and plan future activities.

The raising of awareness on environmental problems and ecological education were important parts of the project. A number of seminars on ecological subject for teachers and headmasters were conducted in each pilot region. Ecological education at schools bridges the theoretical lessons in classrooms with practical activities such as establishment of school gardens and nurseries, seeds collection and trees planting together with the local people. The interest of school children towards ecological issues was easily initiated by the competitions winners of which were awarded by the project and local village administration.

One of the important activities of the project is an information exchange and not only between three pilot regions but between the project and other organizations at the national, sub-regional, regional and international levels. The experience of the project is documented

in brochures and technical manuals, which help in dissemination of experience and "best practices" at the national and international levels.

Special attention is given to desertification problem by the government of Turkmenistan. Since 1998, the National project on planting of greenery and afforestation around the cities and settlements. Afforestation is conducted along the linear objects – drainage canals and roads.

In 2003, the National Program "Strategy of Economic, Political and Cultural Development of Turkmenistan for the period till 2020" was adopted in Turkmenistan. The Program guaranties economic and political independence, ensures the social well-being of population and rational use of natural resources. One of the objectives of the Program is a gratuitous gas supply of the settlements, particular in rural areas. Gas provision will help gradual regeneration of woody and shrub vegetation of mountainous and desert pastures.

In the future, in the framework of the National Program the complex of activities is envisaged for effective use of forage potential of natural pastures. Forage potential of the pastures will be improved by the provision of pastures with water sources on the area of 10 million hectares, by conducting phyto-melioration activities and increasing of forage capacity, by introduction of pasture rotation system and creation of supplementary forage stock.

Designed expansion of pasture areas will happen thank to provision of water sources by using drainage water suitable for animal drinking. This activity will help adding new pasture land previously non-watered to pasture rotation.

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Diseases of Camels, Their Preventive Maintenance and Treatment

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Abstract. This article quotes reported data of researches on camel's diseases. Among the infection diseases the most widespread is brucellosis. There is specific preventing practice developed against brucellosis with use vaccine gained from culture Rev-1.

The dangerous infectious disease for camels is plague. For this case it is recommended vaccination and treatment. In 1940-s in range of regions of Turkmenistan camel's smallpox was registered. Mainly camels aged 2-4 years had been undergone with this disease. To combat the smallpox the vaccination and treatment is recommended. Significant damage caused for camel farms by protozoal and vectorial diseases. Authors described ways of diagnosis, prevention and treatment.

Most often met helminthosis among camels are larval teniasis. Main preventing measure in this disease is dog treatment. There were developed 4 yearly preventing dogs helminthosis prophylaxis. In Turkmenistan there is often encountered sarcoptosis. At this disease it is recommended to use sulfuric compound in the form of ointment and powder with the addition of component "K".

Introduction

The camel breeding in Turkmenistan is one of the most important branches of stock rearing. However, under the country conditions the most intensive development of branch has been held in control by different infectious diseases of parasitic and no contagious nature.

Brucellosis

Today among the number of infectious diseases doing damage to camel breeding the brucellosis deserves special attention. Camels Brucellosis is infectious, chronically elapsing disease. It is caused by the microbes relating to the *Brucella*. Disease from animals can be transferred to people. The most dangerous for people is the brucellosis agent of sheep and goats. Disease is accompanied with abortions, infertility, birth of nonviable saplings, with decrease of the productivity, animals prematurely culled out. All this causes significant damage to farms.

First in Turkmenistan there was studied camel's brucellosis by Ch. Kerimov and M. Iskandarov (1999) [6].

In camel farm "Sakarchaga" of Mary there was revealed camel brucellosis with affecting of livestock in the individual herds up to 13% prevalence rate. The young camel of one year old and adult camels fell ill. Immunological detection of latent brucellosis of camels

was studied with the sero-agglutination test. Ring test (RT) with the milk of dairy female camels was applied. A specific preventive prophylaxis of camel brucellosis was achieved with the application of a vaccine from strain 19 and REV -1 at the different doses.

There was established the epidemiological role of camel milk, *chal*, *agaran* in the disease spreading to human. Liquid live vaccine from the strain ROAR -c1 was successfully adapted in the form of *B. melitensis* prepared for the preventive prophylaxis of camel brucellosis. For the first time, immune status of newly born camel was studied. Tested brucellosis diagnostic was prepared from the local strains for serological diagnostics of animal brucellosis in the farms of Turkmenistan.

Plague

Plague is the dangerous infectious disease of rodents, cats, camels and people caused by *Yersinia Pestis.* Camel was repeatedly a dangerous source of the infection for people with plague. In 1955, M.I. Sotnikov, V.N. Lobanov, I.I. Kurayev [13], and others searching the most effective method of infection and determining the minimum lethal dose of agent, infected 15 camels.

The culture was introduced to two camels into the tracheas and to thirteen camels -into the vein. It became clear that the best method of infection is intravenous. In this case 8 camels dead with the features of sepsis and 4 camels recovered after the heavily elapsing sepsis, one camel did not react to the infection. During the intro-tracheal infection in both camels there was noted short-term fever, also, in one case the inflammation of right prescapular lymph node. There was established that the bubonic form can arise as a result of bite by the infected fleas and mites. These facts have high epidemiological value, since they usually sick camels are slaughtered for meat. The clinical presentation of camels plague, reproduced in the experiment allowed for the first time to trace the course of this illness in the dynamic of infectious process.

The bubonic form of camels plague is accompanied: A) with the rise of body temperature to 40.0 – 40.5 °C, with arrhythmia and an increase in the pulse quantity to 40 - 44 per minute, chill, oppression and emaciation; b) with lameness, with the formation of buboes in the inguinal or pre- scapular lymph nodes, by the presence in these cases of extensive, cold test hypodermic edemas, which apply to entire region of the belly and breast. Pathologic processes with the bubonic form of plague are expressed by hyperplasia of lymph nodes, by acute serious pyonecrotic lymphadenitis. A bacteriological study of puncture specimen from the lymph nodes can serve as one of the early methods of diagnostic of plague in camels [8].

Camelpox

According to the data of S.S. Krupenko (1972) [7] in Turkmenistan, camelpox was registered in several regions during January - March 1940 g (Yu. F. Borisovich, M. D. Orekhov, 1966). Subsequently camelpox appeared in the form of small episodes in 1943, 1946 and 1964-1965.

There were fell ill mainly animals at the age of two - four years. As usual camelpox appeared during June – September. It coursed benignly: animal recovered easily, locally within the short period of time. As the author writes, the disease of camels with camelpox, which was observed in 1972 (January, February and March), coursed in the malignant form with the clearly expressed signs of the generalized process, the death of old camels and young animals at the age to two years. In one drove the camelpox appeared in January and

within 10-15 days rapidly was extended in the remaining eight camel herds and caused significant economic damage. In sick animals there were noted the high body temperature (41°C), lost of appetite, nodular - pustulous rash on the mucosa of tongue, gums, skin of lips and other hairless sections of the skin - perineum, of the udder, scrotum and vagina. In separate adult camels and young animals at the age to two years there were observed the confluent generalized form of camelpox, which covered entire surface of body and neck in form of eczema, the strong inflammation of eyes conjunctive, mucus secreting, keratitis, causing the blindness. Some animal mainly laid and rose hardly.

For the eradication of camelpox on farms, the general immunization of all healthy camels is carried out with vaccine. In adult animals after the vaccine application to the scarified skin in the lower part of the neck on 3-5days noted insignificant inflammatory reaction in the form of swelling, and on 8-10 there were papules, which gradually got dry. Then after 0-25 days remained only painless skin spot. In the separate one-year old camel, camelpox was observed with the clearly expressed damages of the skin of lips, gums and nasal cavity. There was superimposed quarantine onto affected camel farms.

After the thorough clinical inspection of camels with camelpox, they were isolated and carried out with symptomatic treatment. The areas of camel's location after mechanical cleaning are periodically disinfected with the formalin 2%- solution.

Trypanosomose

Significant economic damage to the development of camel breeding was due to protozoal diseases. V.L. Yakimov [14] at the beginning of 20 century studied the geographical distribution of different diseases of domestic animals, and also for explaining their reasons and the development of the measures to fight them in Turkmenistan (including towns: Mary, Kushka and Ashkhabad).

One of the essential results of this work was the establishment of wide spreading among the camels (were studied smears of the peripheral blood more than in 5000 individuals) of trypanosomose - the disease, from which the mortality of animals reaches to 100%. On the basis of morphological data and biological characteristics of the obtained parasites as the agent of this illness, under our conditions there were determined protozoa belonging to the new form of flagellates which are described by the name *Trypanosoma ninaye koyulyakimovaye* Yakimoff, 1918 [14].

It is established that these protozoa whose size varies from 18.8 x 1.4 to 25.5 x 2.8 μm, have wide distribution among the camels and their general invasiveness in some places of the Murgab oasis (for example in Kushka) reaches to 16,6%.

Authors in detail described symptoms and anatomo-pathologic changes during this illness, the methods of diagnostics and treatment. There were supposedly determined the ways of infecting the animals and information concerning its preventive maintenance.

The problem of camel trypanosomose in Turkmenistan, whose study was begun by V.L. Yakimov [14] at 1913, underwent its further development in special studies of O.M. Nuryshev [9], who paid special attention to epizootiology, clinical aspect and the treatment of this illness.

He showed that trypanosomose is encountered among the camels not only in Murgab oasis but also is observed in animals in the Amudarya flood lands. These data substantially enlarge the area of the agent itself and the disease caused by it under our conditions.

It is established that trypanosomes which parasitize in animals on the north of Turkmenistan, had sufficiently large size and their length reached to 25.9 μm while their size in the south of republic was 20.7 to 23.1 μm. It is determined, that in different biotopes in the flood lands of the named rivers dwell the gadflies belonging to 5 forms and subtypes (*Ta-*

banus pulyuellus, T. leleani, etc.). However, in the work cited there are no direct indications about the participation of these insects in the circulation of the trypanosoma agent in nature.

By the way, there was not indicated also the specific name of agent itself and therefore it is possible only to assume that the author dealt to *T. ninaye- koyulyakimovaye*, described earlier by V.L. Yakimov [14]. It is possible also only to assume that the author, speaking about the gadflies, mentioned them as the transmissible factor of parasites. Probably therefore he writes that trypanosomose is observed among all age-qualification groups of camels from May to September and this time completely coincides with the propulsion period in the nourishment of gadflies with the animals blood. It is established that for diagnosis of disease there should be used agglutination test as the most precise and specific in early stages. In this case one should take the antigen, obtained according to the method by E.M. Rafalovich and B.D. Durdyev. This method proved to be more active and convenient in the work. On the basis of many experimental variants carried out on the dogs and the camels the author supposed that during the treatment of trypanosomose very effective are such preparations as naganin and azidin, which can be used also for the purpose of the disease chemoprophylaxis. According to the data of this author, some questions of veterinary science, connected with trypanosomose (for example its diagnosis, the pathogenesis of disease, etc.) were studied previously by Z.P. Korniyenko and A.M. Korniyenko, by B.D. Durdyev and G.M. Mukhadov [9].

Serological and parasitological data by A.S. Berdyev [2,1] witness except trypanosome the sufficient frequency of the occurrence on the territory of our state among the camels and other animals also toxoplasmosis and sarcosporidiosis. The camel breeding bears large loss brought by blood-sucking dipterous insects, especially gadflies. According to the data by Davletklycheva (1999-2002) [4] in Turkmenistan, 41 forms and subtypes of the gadflies were registered from which 3 forms cause trypanosomose of camels. For dealing with the carriers of camel trypanosomose were adapted “sebitsil-50”, “proteid”. The preparations of “sebatsil-50”, of 0.05% of concentration, “proteid” in 0.03%- concentrations protect animals from the attack of gadflies during 8 days. Epizootiology of larval tabanides in camels and the development of the measures of fight against them in Turkmenistan were studied by M.D. Orekhov, D.F. Stepanov, 1971 [10].

As a result of observations and studies there was established that the carriers of mature insects and the spreaders of larva among the camels and other ruminant animals in Turkmenistan are mainly herd and farm dogs.

Other Parasitic Diseases

The dromedary of Arvana breed evidently is little receptive or completely unreceptive to hydatidosis because on 249 dissected and inspected camels the larva *T. hydatigena* is not discovered at all. This problem cannot be considered as finally solved because in the various monographs on helminthoses of the domestic animals (E.I. Ivashkin, 1955) the camel *Camelus bacterianus* and *C. dromedarius* indicated as the intermediate carrier of *Taenia hydatigena* (Pallos, 1766).

The results of the general anatomopathological and partial helminthological dissections of ruminant for larval echinococcosis showed that *E. unilocularis* is encountered in all domestic animals - in livestock, camel, sheep and goat. The greatest damage was established in sheep -25.2%, on the second place on the receptivity stand camels -22.5%, on the third place large livestock -8.8%.

Special helminthological dissections carried out showed that *E.unilocularis* in camels are localized most frequently in the liver. On camels, the echinococose bubbles in anatomic and morphological structure in 53.3% of cases of finding are *E. Veterinorium*. *E. acephalo-*

cytis was discovered in 37.8% cases, *E. Hominis* - in 6.7% cases of the cases. In partial helminthological dissections on 17 camels, caenurosis in especially unhappy farms with this illness (*C. Cerebralis)* was discovered in one young animal 8 months old. As a result of observation and the experimental works by M.D. Orekhov and D.F. Stepanov (1971) [10] on the study of epizootiology of *larval taeniases* of ruminant animals in Turkmenistan made it became possible to develop the most rational periods of dogs deshelminthisation.

In the fight with larval tenidiosis of ruminant animals it was recommended to conduct in Turkmenistan 4 preventive deshelminthisations of sheep and farm dogs within the following specific periods: the first - during February, the second - during April, third - during September and the fourth - during November. The rural and urban dogs that are infected with taeniasis considerably less frequently should be deshelminthed twice: during February and November.

Cephalopinose

Cephalopinosis is the chronic disease of camels, caused by the larvas of camel gadfly, that parasitizes in the nasopharynx and is widely spread among the camels maintained in the cultural zone and near the rivers. In some regions of republic, the extensiveness of the infection of camels by the larvas of gadfly reaches 96-100% (Sh. Charyev, 1986) [3]. The author established that in Turkmenistan the camel gadfly gives two generations per annum: autumn - spring (wintering) and summer.

The first generation is developed during eight months (from the beginning of September to the end of April), the second - is not less than four months (from the beginning of May to August- September). The flies of the wintering generation have place from the third decade of April or beginning of May to the second decade of June, summer- from the end of August to the middle of November.

Camel gadfly belongs to viviparous insects. After pairing with the male in the uteroformed receiver of female there are developed to 700-800 larvas and it is able to infect 20 or more animals. In the organism of the carrier of larva the three stages of development are passed and they increase to the length from 0.7 to 30 mm. The larva of the first stage dwell in the locks of the ethmoid bone and the nose shells, some of them penetrate the frontal sinuses. The larvas of the second and third stage are localized in the dorsal and rarely in the central pockets of nasopharynx. In the lateral pockets of nasopharynx they are noted on the strongly invaded animals. The larvas of the first stage are encountered in camels throughout the year: the maximum number of larvas of spring infection falls on July, autumnal - on November and December. The larvas of the second stage are encountered on animals from January to October. The larvas of the third stage are encountered in animals from February to November, the most numerous larvas of these stages - during March-April and August-September. At the end of the development of the third stage larva, they penetrate the front third of lower nasal passages, whence through several hours fall out to the soil and, after being buried in the surface layer they become chrysalides. Separation for the larvas of the wintering generation begins in first half of March, becomes mass during April, ends to June, and pupation of the larvas of summer generation starts during August - September.

The development of pupae is continued depending on the temperature of soil from 15 to 42 days. All larval stages of camel gadfly cause harm to animals. The larvas of the first stage by their oral hooks and by the numerous probes of the abdominal side of body cause irritation and mechanical damage of cloths that leads to the catarrhal inflammation of the mucous membrane of nose cavity. More serious pathologic changes are noted in the nasopharynx where the larvas of the second and third stage are localized. The products of the inflammation of mucous membrane and vital activity of the larvas of gadfly lead to the

sharp aggravation of inflammatory processes. The appearance of swelling in the places of the accumulation of larvas causes the deterioration in the general status of the health of animals. Under the republic conditions the morbidity of camels with clear expressed clinical signs of cephalopinosis.

In these periods it is necessary one time in 15-20 days to conduct the general inspection of camels for the detection and the treatment of sick animals.

For treating cephalopinosis, watering with 0.03% - aqueous solution of chlorophos is possible. Before twenty-four hours till the supply of solution animals do not drink. With the very heavy form of cephalopinosis the 0.03%- solution of chlorophos in a quantity of 2.5-3 l is introduced into the mouth with the rubber bottle. It is established by the author the high effectiveness of the single treatment with chlorophos in the aerosol balloon of "estrozol" aerosol treatment in second half of June and in November- December in the closed rooms. The author established the high effectiveness of early single animals chemotherapy (at second half of June, also, in November- December) the closed compartments/rooms by the special aerosol balloon of "estrozol" with a capacity of 180 ml with the content of 12,5 DDVP, one balloon is calculated for 400 cubic meters of room. B. Sopyev, B. Charyev (1996) [11] report about 100% effectiveness during treatment of camels cephalopinosis with the preparation of "sebatsil" of firm Bayer Germany - in 0.4-0.5% solution by spraying into each nostril the dose of 30-50 ml. The preparation of the solution of sebatsil, dosage and application are simple and convenient.

Mange

Preventive maintenance and treatment of mange is one of the important tasks in the camel breeding. The agents of the camel's disease are the scabby mites (*Sarcopes* scabiei) that gnaw in the upper layer of the skin the numerous tunnels, where they put eggs from which new mites are developed.

Camels constantly scratch, they are dragged along on the ground and they gnaw the struck place by teeth. In affected camels, from the scratching there are formed baldness places, the skin strongly coarsens, the folds appear on it, cracks, from which the blood with pus oozes.

Mange is especially dangerous for the young animals in the winter time. B. Sopyev and B. Charyev (1999) [11] as the therapeutic preparation against sarcoptosis of camels used natural sulfur and its derivatives. They studied the acaricid effect of sulfur on the isolated mites under laboratory conditions. On the basis of obtained data by B. Sopyev and B. Charyev [11] there were comprised the formulas of therapeutic preparation of sulfur and the scientifically substantiated recommendations regarding the fight with the camel mange were developed. Under the farm conditions they treated 1025 heads of sick camels and obtained 90-95% of effectiveness.

The authors in parallel with the sulphur studied the foreign preparations: ivermectine, tsidectine, parakill and baymek and obtained high effectiveness. B. Sopyev and K. Atayev (2002) [12] as mean against mange of camels recommend the use of sulfuric connections in the form of ointment and powder with the addition of component "K". Therapeutic effect was 98%-100%. Among the young animals frequently affected, the disease is connected with the disorder of gastrointestinal tract. R. Garadurdyev, M. Iskandarov (1999-2002) [5] for the first time under the conditions of Turkmenistan studied the action of the roots of licorice and the althea, which grow in our country, for treatment and preventive maintenance of the gastrointestinal diseases of young camel Therapeutic and prophylactic works were carried out in the farm conditions, where occurred cases of the disease on young camel. The authors for treating the disease adapted the roots of licorice in solution of 1:20

at the dose of 250 ml for the head, the roots of althea in solution of 1:30 at the dose of 300 ml for the head.

Preparations were fed 2 times in a 24 hours period to the feeding of young camel in the course of 6 days. At the preventive maintenance of disease the preparation at the same proportions and doses were assigned 1 time a day during 6 days. The effectiveness of preparations during the treatment was 92.3% and 84.5%, and with the preventive maintenance respectively -97, % and 91,4%.

References

[1] **Amangulyv A. et al., 1998.** Parasites of animals and natural locality of diseases in the valley of Amudarya in the zone of Karakum channel. Ashkhabad.
[2] **Berdyev A.S., 1974.** Toxoplasmosis, Ashkhabad, Ylym.
[3] **Charyev S., 1986.** Prophylaxis and treatment of cephalopinosis of camels in Turkmen SSR recommendation of the research institutes of the Ministry of Agriculture TSSR (1980-1984), Ashkhabad.
[4] **Dovletkylychev A.** Final report of the institute of livestock and veterinary science of the association of "Turkmenmallary" for 1999-2002.
[5] **Garadurdyev R., Iskandorov M., 2002.** Final report of the institute of livestock and veterinary science of the association of "Turkmenmallary" of Turkmenistan.
[6] **Kerimov H., Ikandarov M., 1999.** Prophylaxis and the sanitation of camels and large livestock against brucellosis. Scientific guarantee for development of livestock. Ashkhabad, p. 36-37.
[7] **Krupenko S., 1972.** Camelpox, caused by pox vaccine (detrite). Veterinary science, 1972, N°8, p. 161-62.
[8] **Martynchenko V.A., 1967.** Bubonic form in camels. Collection of works on the veterinary science. Ashkhabad, p. 20-23.
[9] **Nuryshov O.V., 1969.** To a question of diagnosis, treatment and preventive maintenance of tripanosomose (Surra) of camels. Author's abstract of candidate thesis. Ashkhabad, 16 p.
[10] **Orekhov M.D., Stepanov D.F., 1972.** Epizootiology of larval tenidiosis of ruminant animals and the development of the measures of fight with these illnesses in Turkmen SSR. Development of Livestock. Turkmenistan in the years of the Soviet regime. Ashkhabad, p. 160-168.
[11] **Sopyev B., Charyev B., 1999.** Fighting with sarcoptosis of camels. To development of livestock - scientific guarantee. Ashkhabad, p. 48.
[12] **Sopyev B., Atayev K., 2002.** Recommendations regarding the final report of the institute of livestock and veterinary science of the association of "Turkmenmallary" for 1999-2002.
[13] **Sotnikov M.I., Lobanov V.N., Kurayev I.I., Martynchenko V.A., Burlachenko T.A., Guvva L.A., 1960.** The effectiveness of the camel vaccination by living dry plague vaccine. Questions of natural focality and epizootiology of plague in Turkmenistan. Ashkhabad.
[14] **Yakimov V.L., 1915.** The transactions of expedition for the study of the tropical diseases of people and animals of Turkmenistan edge in 1913 Leyimaniozy Petrograd, Vol. 1, 107 p.

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The Most Important Infectious Diseases in Camelids

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Abstract. The present paper gives a list of the main camel diseases with some pictures.

The camelids family has become the focus of increasing study over the last few years because it is a source of milk, meat and wool as well as transportation and labour for millions of people in developing countries. As with other mammalians, the camelids may suffer from viral, bacterial, fungal and parasitic infections, of which the most important ones are presented here. Furthermore, due to the importance of neonatal diseases, parts of this paper are also dedicated to the unique antibodies of camelids and to vaccination programmes for viral, bacterial and fungal diseases.

The following infectious diseases of camelids are discussed:

- Rabies
- Camelpox (photo 1)
- Ecthyma contagiosum (photo 2)
- Papillomatosis
- Influenza (photo 3)
- Rotavirus
- Equine herpesvirus
- Borna disease

Photo 1. Camelpox.

Photo 2. Ecthyma contagiosum.

Photo 3. Influenza.

Photo 4. Enterotoxemia due to Clostridium perfringens.

Photo 5. Tetanus.

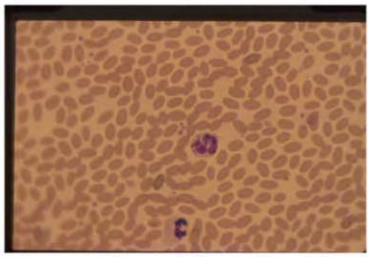

Photo 6. Rickettsia in camel blood.

Photo 7. Lesion of tuberculosis.

Bacterial diseases:

- Anthrax
- Anaerobic infections (photo 4)
- Tetanus (photo 5)
- Paratuberculosis (Johne' disease)
- Endotoxaemia in racing camels
- E. coli infections in camel calves
- Salmonellosis
- Pasteurellosis
- Rickettsiosis (photo 6)
- Tuberculosis (photo 7)
- Melioidosis
- Chlamydophiliosis
- Rhodoccus equi in New World Camels
- Brucellosis

Fungal diseases:

- Mycotic dermatitis (photo 8)
- Aspergillosis
- Coccidioidomycosis in New World Camels

Photo 8. Ringworm lesions.

Photo 9. Trypanosoma evensi in camel blood.

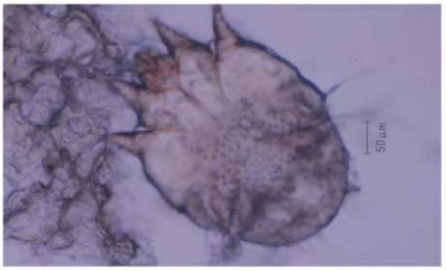

Photo 10. Sarcoptes scabiei, agent of the mange.

Parasitic diseases:

- Trypanosomosis (photo 9)
- Sarcoptic mange (photo 10)
- Coccidiosis
- Infection with Nematodes
- Infection with Trematodes (Flukes)

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Fungal Infection of Camelids

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Abstract. Fungi that reproduce by asexual spore formation only are known as "Fungi Imperfecti" which include the vast majority of fungi animal pathogens. These include Epidermophyton, Microsporum, Trichophyton*, Sporotrichum, Candida*, Cladosporium, Coccidioides, Blastomyces dermatitidis*, Histoplasma capsulatum*, and Aspergillus fumigatus*. Most of these fungi have been reported to cause various diseases in camelids. Fungi in the genera Trichophyton* and Sporotrichum are the most prevalent fungi in camelids. Trichophyton verrcosum, T. *mentagrophytes, Microsporum canis and M.* gypseum have been isolated from camels in upper Egypt while T. *dankaliense was isolated from cases of ringworm in camels and humans in the northern and Ogaden areas of Somalia. Ringworm due to T.* schoenleinii has been recorded in camels from Iraq and India. Other Fungi also reported to infect camels include T. *rubrum, Allescheria boydii and Mycelia* sterial.

Direct contact ith other infected animals or the use of contaminated utensils is the common method of spread. Introduction of new camels with subclinical infection is usually the source of infection to susceptible herds. Other rarely reported fungal diseases of camelids include candidiasis caused by Candida albicans, cryptococcosis due to Cryptococcus neoformans*, aspergillosis due to Aspergillus fumigatus*, Histoplasma capsulatum *var farciminosum, Sporotrichum schenckii*, Rhizopus spp, and Conidiobolus coronatus *infection.*

Mycotoxicoses is a potential hazard of fungal toxins in foodstuffs. Ryegrass staggers as a clinical disease has been diagnosed in cattle, sheep, horses, alpacas and llamas following the ingestion of mycotoxins produced by the endophyte fungus Acremonium lolii*. Phalaris poisoning caused by Phalaris aquatica* grass has been diagnosed in an alpaca in Australia in regions where sheep losses also occur from poisoning. Mycotoxicosis from the fungus Epchloe typhina *has been reported in llamas following grazing tall fescue grass. Some strains of Aspergillus flavus* produce aflatoxins, which are toxic to the liver.

Diagnosis of fungal diseases can be achieved by direct examination of clinical materials, isolation on specific media, various serological tests, histopathological examination of tissue biopsy specimens, experimental animal inoculation transmission, and intradermal allergic tests.

Antifungal drug therapy has been used to treat camels suffering from fungal infections. Various drugs are commercially available in the markets. These include amphotericin B, nystatin, grisseofulvin, imidazoles, ketoconazole, clothimazole, fluconazole, itiaconazaole, and sodium iodide. Prevention and control of fungal diseases depends upon elimination of the infection by isolation of infected animals, and preventing spread by hygienic precautions and the use of vaccines.

Introduction

In general, the camelids include two genera. The first genus is Camelus comprises two species: the Arabian camel (Camelus dromedarius*) and the Bactrian camel (Camelus bacteri-*

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anus). These are commonly known as the "Old World camels". The second genus is Llama *includes four species: llama (Lama glama*), alpaca (Lama pacos*), guanaco (Lama guanicoa*) and vicuna (Lama vicugna) [1,2].

Fungi are eukaryotic microorganisms. Mycologists estimate that there are approximately 1.5 million species of fungi, of which approximately 400 species have been proven to be agents of disease in humans and animals. Of these, only a few are common pathogens for camels [46].

1. Classification of Fungi

Most 19th century biologists considered fungi to be primitive plants and grouped them in the Kingdom Plantae until 1969 when fungi were classified into a different kingdom. The classification of fungi is based primarily on reproductive structures, although the basis of fungal taxonomy has begun to reflect data from molecular genetics.

Pathogenic fungi belong to four of the six classes included in the kingdom Fungi. Members of this heterogeneous group are scattered throughout four taxonomic classes based on their methods of reproduction. Fungi of these three classes (Zygomycetes, Basidiomycetes and Ascomycetes) produce sexual spores, so they are known as "perfect fungi". Sexual spores are absent in fungi of the fourth class (Deuteromycetes). They reproduce by asexual spore formation only, so they are known as "Fungi Imperfecti" and include the vast majority of fungal animal pathogens [46]. The classifications of the four classes are as follows:

- Class: Zygomycetes - Zygote production follows fusion of iso-gametangia at hyphal tips. For example: Mucor spp, Absidia spp, Basidiobolus spp and Conidiobolus spp.
- Class: Basidiomycetes - Sexual spores are borne externally on special club-shaped cells called basidia. For example: Filobasidiella neoformans.
- Class: Ascomycetes- sexual spores are produced within an ascus, such as Ajellomyces dermatitidis*, Arthroderma spp., Emmonsiella capsulatum*, Nannizzia spp. and Sartorya fumigata.
- Class: Deuteromycetes (Fungi Imperfecti) include Epidermophyton, Microsporum, Trichophyton, Sporotrichum, Candida*, Cladosporium, Coccidioides, Blastomyces dermatitidis*, Trichophyton spp, Histoplasma capsulatum*, Microsporum spp*. and Aspergillus fumigatus.

Fungi can be divided into different morphologic forms. The two basic morphologic forms are yeast and molds. Yeast and molds are not always mutually exclusive; a fungus may assume one or both of these forms under different growth conditions. Yeasts are unicellular oval or spherical cells, usually about 3 to 5 mm in diameter, and reproduce asexually by a process termed "blastoconidia formation" (budding), or by fission. In molds, spores germinate to produce branching filaments called hyphae, about 2 to 10 mm in diameter, which are tube-like extensions of the cell with thick, parallel walls. As a colony grows, its hyphae form a mass of intertwining strands called "mycelium", which are delineated into two types that differ in function: the vegetative mycelium (responsible for nutrition), and the reproductive mycelium. Reproductive hyphae often produce specialized structures called "conidia" that are easily airborne and disseminated into the environment. Some fungi, for example Histoplasma capsulatum*, can exist in mycelial or yeast morphology depending on the environmental conditions of growth. This capacity is known as "dimorphism" and is clinically important because most of the more pathogenic fungi are dimorphic: they usually appear in infected tissues as yeast-like cells, but appears in cultures as saprobes or typical molds.*

Diseases caused by fungi are called "mycoses", **and fungi are capable of causing a wide spectrum of diseases and infections in camels as well as other domestic animals. Fungi may cause disease in various parts of the camel's body, which can be divided into:**

- Superficial mycosis, involves the skin and fur. Causative agents include the dermatophytes, species of the genera Epidermophyton, Microsporum and Trichophyton. The name given to these infections is "ringworm", "dermatophytosis" or "tinea".
- Systemic mycosis, involves internal organs, and is caused by primary pathogens such as Histoplasma capsulatum*, Coccidioides immitis* or by opportunistic pathogens such as Aspergillus fumigatus*, Candida albicans* and Cryptococcus neoformans*. Hypersensitivity pneumonitis with cough, fever, lethargy, and pulmonary infiltration may result following Aspergillus fumigatus* infection.
- Subcutaneous mycosis, involves the subcutaneous tissues. Histoplasma capsulatum *var farciminosum or Sporotrichum schenckii* are examples. In addition, fungi may cause mycotoxicosis which occurs via ingestion of poisonous food materials.

2. Epidemiology of Fungal Infection

Most fungal infections arise from contact with an environmental reservoir or infected animal. Close contact with an infected animal is probably the main source of infection. Also, there are reports of camels acquiring infection with Trichophyton schoenleinii *from infected humans* [6,12].

3. Geographic Distribution

A few of the dermatophytes are considered to be obligate parasites, but the majority of the pathogenic fungi are widespread in the environment such as saprophytes, or are present as commensals and are associated with animals and humans [46].

4. Natural Defense Mechanism

Healthy camels have a high level of natural immunity to fungal infections. Natural resistance is of a non-specific type and depends on genetic factors as well as age, sex, nutrition, and hormone balance. Other factors are the mechanical barriers of intact skin and mucous membrane, surface secretions (fungicidal fatty acids in sweat and sebaceous material), anatomical traps of the nasal cavity, and the mechanical cleansing action of the cilia in the respiratory passageways. Organisms which penetrate these barriers stimulate an inflammatory response and are subjected to phagocytosis by circulating and tissue-fixed phagocytic cells. In addition, exposure to the fungal antigen initiates antibody production and cell-mediated immune response. The common use of potent immunosuppressive and cytotoxic therapies has produced animals with seriously impaired immune defenses, and fungi that are non-pathogenic to healthy animals become pathogenic. Antibacterial therapy has also created ecological situations in which opportunistic fungal infections can flourish.

5. Pathogenesis

In camels, many pathogenic fungi limit their activities to the skin, producing superficial mycosis [1]. Those that cause systemic infection (deep mycosis) such as Histoplasma capsulatum, *Coccidioides immitis* and Blastomyces dermatitidis, *all cause pulmonary disease following the inhalation of the infective forms of the organism* [11,18,19,29,38,39,53]. *For many fungal pathogens, the effective tissue response to invasion is granulomatous inflammation32,45. Since granulomatous inflammation is a tissue hallmark of cell-mediated immunity, this implies that acquired immunity is required for an effective host response to some fungal pathogens. Some fungal pathogens like Candida albicans* and Cryptococcus neoformans *can establish latent infections that persist in tissue and can reactivate if the host becomes immunocompromised.*

6. Factors Involved in Pathogenicity of Fungi

- Adherence to the mucosal surface usually requires a surface adhesion to the microbe and a receptor on the epithelial cell. For example, mannoprotein components extending from the cell wall of Candida albicans *have been implicated as the adhesion, and fibronectin and other components of the extracellular matrix as the receptors. Specific binding mediators have been identified for other fungi.*
- Invasion by passing an initial surface barrier, such as skin or mucous membrane is an important step for most successful pathogens. Some fungi are introduced through mechanical breaks. For example, Sporothrix schenckii, *the cause of sporotrichosis, typically follows a thorn prick in the skin or some other obvious trauma. Extracellular enzymes (proteases, elastases, etc) have also been associated with virulent and invasive species of Candida* and with some of the dimorphic systemic fungi.
- Phagocyte interactions by certain types of fungi have been studied. For example, Coccidioides immitis has been shown to contain a component in the wall of its conidial (infective) phase that is antiphagocytic. As the hyphae convert to the spherule (tissue) phase, they also become resistant to phagocytic killing because of their size and surface characteristics. Also, it has been found that Candida albicans *is able to bind complement components in a way that interferes with phagocytosis.*
- Tissue injury by exotoxins (mycotoxins) has been proposed, but direct evidence is lacking. It seems that injury caused by fungal infections may be due primarily to the inflammatory and immune responses that are stimulated by the prolonged presence of the fungus.

7. Diagnosis of Fungal Diseases

When cutaneous mycotic infection in camels is suspected, two basic procedures should be performed to determine whether the disease is mycotic in nature: direct examination of clinical materials, and isolation and subsequent identification of the fungi recovered [36,46].

7.1. Sampling

The collection of specimens requires the following chemicals: alcohol for cleaning the skin, sterile scalpels, forceps, scissors, and clean paper envelopes. The scales from the active

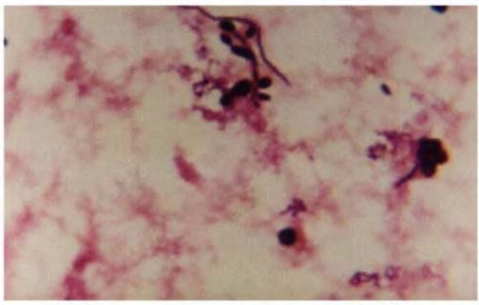

Figure 1. Direct smear stain of a milk sample. See Cryptococcus neoformans *bodies with inflammatory cells.*

Figure 2. Culture growth of T. mentagrophytes *on mycobiotic agar.*

borders of the lesions should be scraped with a scalpel. Hairs from infected areas can be plucked out with forceps and submitted for examination. Specimens should be enclosed in paper envelopes with full identification and submitted for laboratory examinations.

7.2. Direct Smear Stain

Fragments of skin scrapings, hair or scales should be placed in a drop of 10% KOH on a slide, and a cover slip added. The slide should be gently heated over a flame for a few seconds, but avoid boiling. Infected skin scrapings show septate, branched hyphae and arthroconidia in chains. In general there are certain terms used to describe hair infection. “Ectothrix” and “endothrix” refer to the location of arthroconidia in relation to the hair. In ectothrix infections, the arthroconidia are observed outside the hair shaft, surrounding it in the form of a sheath. Endothrix infections occur when arthroconidia formed by the fragmentation of the hyphae are found inside the hair shaft.

7.3. Culture

The fungal agent involved can only be identified through the isolation and study of cultures. Animals with KOH-negative specimens might yield positive cultures. Mycobiotic agar, Sabouraud’s agar, and blood agar are the media most commonly used for the isolation of dermatophytes from clinical materials. Cultures are incubated for 2-4 weeks at 24-28°C (room temperature) and at 37°C.

Figure 3. Mycelia of T. verrucosum *stained by lactophenol cotton blue stain.*

7.4. Identification

Dermatophytes species are identified on the basis of both their gross colony characteristics and their microscopic morphology. A slide culture technique may be used for this purpose. Lactophenol cotton blue stain is commonly applied to observe the mycelia and spores. Conidium production may not occur for days or weeks after the initial growth of the mold. An alternate approach has been developed for identification of some of the dimorphic fungi, based on soluble antigen prepared from mycelial growth (exoantigens), and is called "the exoantigen test". When these exoantigens react with specific antibody in an immunodiffusion procedure, precipitin lines are formed between the unknown antigen and its homologous antibody. Presently, PCR is used quite frequently for species identification.

7.5. Serological Tests

Serological tests for fungal diagnosis have limited laboratory applications, but certain fungal infection such as aspergillosis, epizootic lymphangitis, and candidiasis may be diagnosed in this manner. The tests used agar-gel immunodiffusion, hemagglutination, ELISA, CFT, and fluorescent antibody tests.

7.6. Histopathological Examination

Histopathological examination of tissue biopsy specimens is widely used and shows the relationship of the fungi to tissue elements and responses (eg, granulomatous reaction). Most fungi can be seen in tissue sections stained with the haematoxylin and eosin (H&E). Specialized staining procedures such as Gridley's method, Grocott's silver impregnation method, Pickett's fluorescence method, and periodic acid-Schiff (PAS) stain are frequently used because they stain almost all fungi.

7.7. Electron Microscopic Examination

Tissues taken from lesions can be examined by electron microscopy and used to identify the fungi and study morphological details.

7.8. Animal Inoculation

Experimental transmission of fungus from infected camels to laboratory animals such as rabbits, guinea pigs, and mice have been attempted. Immunosuppression of the laboratory

animals by corticosteroids makes the animal highly susceptible to experimental infection, and can be used for diagnostic purposes.

7.9. Cell-Mediated Immunity

An accurate and reliable method of skin testing is the intradermal test for diagnosis of certain fungal diseases. This consists of intradermal injection of 0.1 ml of soluble antigen prepared from the fungus. An increase in skin thickness for 24 to 72 hours post injection of the antigen can be regarded as a positive result.

8. Treatment of Fungal Disease

Antifungal drug therapy has been used to treat camels suffering from fungal infections. Various drugs are commercially available. The veterinarian, however, must realize that fungi are like mammalian cells and unlike bacteria possess nuclei, mitochondria, and cell membranes. Their membranes are unusual in that they contain distinctive sterols. The similarity between fungal and mammalian cells mitigates against selective toxicity, and antifungal drugs are generally more toxic than antibacterial agents. The following antifungal drugs may be used in camels.

- Amphotericin B is the mainstay of therapy for serious fungal infections and remains the most broad-spectrum antifungal agent available. Its broad spectrum of activity makes it the drug of choice for most deep and cutaneous camel mycosis. Amphotericin B is an antibiotic derived from Streptomyces nodosus. *The recommended dose is 0.2 mg/kg/day, and is given as an intravenous infusion freshly prepared in 5% dextrose. The antifungal spectrum of amphotericin B is broad and includes Histoplasma, Cryptococcus*, Sporotrichius, Aspergillus, Candida*, Blastomyces*, Microsporum, and Trichophyton spp infections. This drug works by binding to a sterol in fungal cell walls and increasing their permeability, thus allowing leakage and loss of small molecules such as glucose and potassium ions. The primary adverse effect of amphotericin B is nephrotoxicosis.
- Nystatin is an antifungal antibiotic isolated from Streptomyces. It is highly toxic if given by intravenous injection. It is therefore commonly used as a topical medication on the skin to treat cutaneous fungal infection.
- Griseofulvin was isolated from Penicillium griseofulvium. *Its spectrum is limited to dermatophytes. It interferes with cell division and possibly other cell functions associated with microtubules of the fungi. It is absorbed from the gastrointestinal tract after oral administration and concentrates in the keratinized layers of the skin. Treatment is given orally in a dose of 5 g per camel daily in the feed. If used for a prolonged time period, the main side effect of griseofulvin in camels is diarrhea.*
- Imidazoles are fungistatic at low concentrations and fungicidal at higher concentrations. They are used topically and are active against both dermatophytes and yeasts such as Candida. *They can be administered either orally or topically for dermatophyte infection.*
- Ketoconazole, clothimazole, fluconazole, and itiaconazaole are in the azoles family of synthetic organic compounds. The most important component of their antifungal action is interference with the demethylase responsible for conversion of lanosterol to ergosterol, the major component of the fungal cytoplasmic membrane. This leads to formation of a defective cell membrane with altered permeability charactersitics. Ketoconazole and itraconazole are given orally, and fluconazole is given either orally or intravenously.

Figure 4. Colony of T. verrucosum *on mycobiotic agar.*

- Sodium Iodide in 10% solution intravenously or potassium iodide orally, are older chemotherapeutic agents for the treatment of fungal infection. They have been used quite frequently to treat systemic fungal infections in animals. Sodium iodide must be given by intravenous route and repeated at weekly intervals. Signs of iodism may appear in a treated animal and this is characterized by salivation, restlessness, lost of appetite, and fatigue.

9. Prevention and Control of Fungal Diseases

The long incubation period, the high resistance of the causative agent, and the presence of clinically healthy carriers, make control of fungal diseases difficult in endemic areas. Control of fungal diseases depends upon elimination of the infection by isolating infected animals and preventing their spread by taking hygienic precautions. Infected animals should be treated or slaughtered. Cleaning and disinfection of the environment will help to prevent the disease from spreading. Killed or attenuated live vaccines have been used with excellent results for preventing ringworm infection.

10. Dermatophytosis (Ringworm)

The dermatophytes are a group of closely related fungi that utilize keratin for growth. They tend to be confined to the outer stratum corneum of the skin, claws, and fur of animals. The classical lesions are circular, and known as “ringworm” [4].

11. Etiology

Fungi in the genera Trichophyton *and Microsporum, are the most prevalent fungi in camels* [17,21,23,28,30,34,37]. *T. verrucosum*, T. mentagrophytes*, Microsporum canis*, and M*. gypseum have been isolated from camels in upper Egypt, while T*. dankaliense *was isolated from cases of ringworm in camels and humans in the northern and Ogaden areas of Somalia* [14,16]. *Ringworm due to T. schoenleinii* has been recorded in camels from Iraq, Jordan and India [5,6,12]. *Other fungi rarely reported in camels include T. rubrum*, Aleurisma lugdunese, Penicillum vinaceum, Pseudeurotium spp. Pseudoarachniotus spp.*, Allescheria boydii*, *and Mycelia sterial*.

Figure 5. A 2-year-old Arabian camel infected with ringworm due to T. verrucosum *following direct contact with an infected bovine calf.*

12. Epidemiology

Ringworm, though considered rare in camels, is a major public and veterinary health problem. However, because of the intensive housing of racing camels, the incidence of ringworm is starting to increase. Trichophyton verrucosum*, T. mentagrophytes*, Microsporum canis*, M.* gypseum, *and T. schoenleinii* have been regarded as the main fungi causing ringworm in camels [9,10,16,31,33]. Direct contact with other infected animals or the use of contaminated utensils are common ways in which ringworm is spread. Introduction of new camels with subclinical infection is usually the source of infection to susceptible herds. A mixed infection of M*. gypseum and Dermatophilus congolensis infection in camels reared on a dairy farm has been reported in Saudi Arabia and Kenya* [7,22]*. The housing of infected cattle, sheep, or hoses with camels might be an additional source of infection1* [15]*. There is also a report of transmission of T. schoenleinii from humans to camels* [6]*.*

13. Clinical Signs

Camel dermatophytosis most often appears as several annular or irregular areas of alopecia, gray-white encrustation, and painless lesions, 1 to 2 cm in diameter, that are distributed on various parts of the body, especially the neck, chest, and flank areas [26,27,30,34,48,50]. Ringworm due to T. *schoenleinii was described in young camels in Iraq. Initially, lesions appeared as slight scaling of the skin around the mouth and eyes, and then appeared as heavy encrustations on other parts of the body. The lesions typically consisted of an area of alopecia and a prominent white asbestos-like accumulation of scales* [44]*. The lesions expanded in size, and signs of emaciation and fatigue appeared in most affected animals. Camels between 1-3 years old were more commonly affected than mature healthy camels. In most cases, spontaneous recovery occurred although some camels remained infected.*

14. Diagnosis

Examination of a direct smear by lactophenol cotton blue stain will reveal a large number of arthrospores. The PCR technique, using specific DNA probes, detects species of Trichophyton and Microsporum and is available commercially. Histopathological examination will reveal hyperkeratosis of the epidermis, folliculitis, acanthosis, accompanied mainly by neutrophils, lymphocytes, histocytes and plasma cells.

15. Treatment

Local treatment with 0.5% iodine lime-sulfur ointment or 10% copper sulfate ointment gives good results. Following the removal of the cutaneous crustacean from affected skin, the ointment is rubbed heavily onto the affected areas. Repeated treatments will give a faster and better recovery rate.

An older still effective method of treatment used by Bedouin people, was to apply tar or used car oil on the infected areas, but most veterinarians do not recommend this method. Other methods of treatment include the use of systemic antifungal medication such as amphotericin B, Griseofulvin, ketoconazole, clothimazole, fluconazole and itiaconazaole.

Prevention and control. Infected animals should be separated, and all utensils, instruments, and harnesses must be disinfected. Immunization of all susceptible camels by killed or live attenuated fungal vaccines are recommended. Two doses 30 days apart are recommended and should be followed up by annual revaccination. Camel ringworm is a zoonotic disease, and there are reports of human infection spreading from infected camels. Carefull dealing with such case is recommended.

16. Candidiasis (Moniliasis or Thrush)

This is fungal disease that affects humans and domestic animals, including camels and llamas [24]. Candida albicans *is the causative agent and there is a worldwide distribution. The disease was reported in a llama that exhibited anorexia and diarrhea for three days before death. In rare cases, chronic pneumonia or mastitis may occur in camels given immunosuppression corticosteroids. Candida albicans* can be identified in fresh scrapings of KOH from infected lesions. Gram-stain smears will show small, oval, thin-walled budding yeast cells and pseudohyphae. Characteristic colonies on Sabouraud's dextrose agar grow rapidly, have a smooth, soft, shiny and cream color, and are accompanied by a distinctive yeast odor. In histopathological examination, spherical and ovoid yeast cells (blastospores) and hyphae may be seen. Candida albicans *is usually susceptible to amphotericin B, nystatin, flucytosine, and the azoles.*

17. Epizootic Lymphangitis

Epizootic lymphangitis is a fungal disease of horses caused by Histoplasma capsulatum *var farciminosum. The disease is worldwide, with endemic foci in North Africa and Asia, and is characterized clinically by a cord-like appearance of the subcutaneous lymphatic vessels, and the development of a series of pyogranulomas, that discharge exudate and contain yeast-like cells of the causative pathogen. The disease mainly affects horses, mules, and donkeys, although infection may occur in camels and cattle* [3,11,52].

18. Sporotrichosis

Sporotrichosis is a contagious disease of horses, but rare cases have been recorded in humans, dogs, cats, camels, and cattle. The causative agent is Sporotrichum schenckii *which exhibits reversible dimorphism that is temperature and media dependent. Clinically, multiple small cutaneous nodules develop on the lower parts of the legs, and have the tendency to ulcerate and discharge a small amount of pus laden with the causative fungi. Diagnosis depends on direct microscopic examination and culture of infected pus or tissue.*

The organism grows within 2 to 5 days on ordinary fungal media. In histopathological section, the fungus appears as spherical, oval or elongated budding yeast with irregularly stained cytoplasm. The yeast cells may also be cigar-shaped. Asteroid bodies may occur, which consist of a central spherical or oval basophilic cell, 3-5 mm in diameter, surrounded by a thick, radiate eosinophilic substance. This eosinophilic material is considered to be an antigen-antibody complex. In a mild case, local application of tincture of iodine may be sufficient for treatment. Systemic treatment with 10% sodium iodide solution or amphotericin B is also recommended. To control the disease in endemic areas, avoid housing horses with camels. Bedding, utensils, and harnesses should be disinfected with antifungal solutions.

19. Cryptococcosis

Cryptococcosis *due to Cryptococcus neoformans* is widespread and has been found in soil associated with pigeon droppings. It has also been recovered from normal skin and the mucous membranes of human beings and animals. Intramammary infection may occur in lactating camels following milking with contaminated hands. Also, Cryptococcus *spp have been isolated from meningitis and pneumonia in a vicuna. Minute, focal lung lesions developing as metastases from cryptococcal mastitis have been observed in cattle. These fungi resulted in abortion in a mare and pneumonia in her foal.*

Samples from infected tissues cultured on Sabouraud's dextrose agar revealed rapidly growing, smooth, moist, shiny, and mucoid colonies, initially white in color and later turning cream-colored, then yellow or orange. Smears taken from the colony and stained by Indian ink preparations reveal spherical to oval, thin-walled cells surrounded by a capsule. In histopathological sections, oval or round, relatively thin-walled cells of varying size are seen in circular clear spaces. The spaces represent capsule polysaccharide that lack affinity for H&E stain. Amphotericin B is the best treatment for systemic cryptococcal disease.

20. Zygomycosis

Agents of Mucormycosis (Rhizopus spp*) are saprophytic in nature. Infection is acquired by inhalation of spores or by inoculation. The fungus occasionally causes disease in immunosuppressed animals receiving corticosteroid therapy. The fungus has been isolated from a disseminated, multisystemic infection in a llama. Tissue biopsies are necessary to demonstrate the invasive hyphae. Amphotericin B is the drug of choice for such cases.*

21. Rhinophycomycosis

Subcutaneous phycomycosis has been reported to cause nasal polyps in horses and in humans in tropical rain forest regions [49]. It is caused by Conidiobolus coronatus*, which has also been isolated from a llama. The lesion consists of a nodular dermatosis involving the external narses, muzzle, and the face. The mass obstructs the nasal passages causing dyspnea. Histopathological section examination reveals a broad, thin-wall, branching, and occasionally septate hyphae. They have a varied morphological appearance, stain poorly and are surrounded by eosinophilic cellular debris. On Sabourau's dextrose agar, the colony grows rapidly is initially flat and glabrous, but soon develops radial and irregular folds. Treatment with 10% sodium iodide has given satisfactory results. However, surgical removal of the nodules from the nasal passages is recommended to relieve the dyspnea.*

22. Aspergillosis

Aspergillosis due to Aspergillus fumigatus *and A. niger has a worldwide distribution, and the fungus* is commonly found in decaying vegetation. The spores may reach the respiratory tract and sinuses, and may cause acute pulmonary disease [8,13,50]. Progressive pulmonary infections occur more commonly in camelids with pre-existing, debilitating diseases necessitating by prolonged use of antibiotics or immunosuppressive drugs [40,43]. Systemic aspergillosis due to A. fumigatus *has been reported in racing camels in the United Arab Emirates, especially in those camels imported from Australia.*

Clinical signs include fever, coughing, lacrimation, edema of the throat and submandibular region, and enlargement of submandibular lymph nodes. Less frequent signs include tremor, recumbency, diarrhea, dysentery, and vomiting. At necropsy, affected animals have multiple discrete granulomatous lesions, especially in the lungs, abomasum, and omasum. Pyogranulomatous pneumonia due to A. *niger was reported in an alpaca40. The characteristic sporulating conidiophores may be seen in tissue from lung lesions. On Sabourau's dextrose agar, the colony grows rapidly is velvety in texture, initially white, later turning green to dark green in color. Serological tests have been developed to determine Aspergillus antibodies, but their clinical use is limited.*

Amphotericin B has long been the only effective treatment for invasive or disseminated aspergillosis, and clinical experience with itiaconazaole suggests it may be an alternative. However, in most cases treatment is not recommended, and affected animals are euthanized.

23. Mycotoxicoses

The potential hazard of fungal toxins in foodstuffs was recognized in the eighteenth century, when it was realized that the ingestion of rye contaminated with the sclerotia of Claviceps purpurea *was associated with ergotism in domestic animals* [42,47,49]. *Consumption of ergotized seed heads may result in gangrene of the feet, tips of ears and tip of the tail. Ryegrass staggers as a clinical disease has been diagnosed in cattle, sheep, horses, alpacas, and llamas in New Zealand, Australia, and the United States. Signs occur following sudden or rigorous exercise, and vary from a slight spasm and stiffness of the limbs, to complete tetany. In severe cases, animals remain prostrate and may starve. The causative factor is believed to be mycotoxins produced by the endophyte fungus Acremonium lolii*. A photosensitization of alpacas was reported in New Zealand and Australia. Weather conditions, which result in warm ground temperatures and high humidity, are required for prolific growth of the mold Pithomyces chartarum.

The primary lesions are confined to the liver, and bile ducts. Clinically, affected animals exhibit facial dermatitis following exposure to sunlight. Phalaris poisoning caused by Phalaris aquatica *grass has been diagnosed in an alpaca in Australia, in regions where sheep losses also occur from poisoning* [25,33,41]. *Signs appear when the animals are disturbed. Hyperexcitability and generalized muscle tremor, including nodding of the head, occur first. On moving, the limb movements are stiff and the hocks are inflexible, causing dragging of the hind feet. Incoordination and swaying of the hindquarters follow. In the most severe cases, tetanic convulsions occur with lateral recumbency, paddling movements of the legs, and irregular involuntary movements of the eyeballs. Mycotoxicosis from the fungus Epichloe typhina* has been reported in llamas following grazing tall fescue grass (Festuca arundinacea). *Signs of weight loss, a dull rough hair coat, anorexia and elevation in body temperature were reported.*

Aflatoxicosis resulting from the vasoconstrictor properties of the ergot alkaloids occurs frequently following wet, rainy seasons that are favorable to the growth of the fungus in the ears of grains. Almost all plant products can serve as substrates for the growth of mold. When contamination is heavy as a result of a damp growing season, or when grain is gathered and stored before it is dry, molds grow and some species produce mycotoxins. Mycotoxins may play a role in intoxication in camels [20]. Gliotoxin, an epidithiodioxopiperazine mycotoxin, is a metabolite from fungi such as Aspergillus fumigatus. *Consumption of the partially heavy molded hay by camels, clinical symptoms of mycotoxicoses such as diarrhea, hemorrhage and death have been observed. Ingestion of grain infected with Fusarium is associated with liver damage. Some strains of Aspergillus flavus produce aflatoxins, which are toxic to the liver. Inhalation of fungal spores during the feeding of contaminated grain or other feed stuffs or during exposure to contaminated dust, can give rise to respiratory disease. This may result from direct invasion of respiratory tissue by the fungus or from allergic responses that cause rhinitis and asthma.*

In order to protect individuals from the hazards of mycotoxins, contamination of grains and hays by mould must be reduced to a minimum, and attention given to storage and quality control.

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References

[1] **Al-Ani F.K.** (2004) Camel Management and Diseases. Al-Sharq Printing Press, Jordan.
[2] **Al-Ani F. K.** (2003). Camel Encyclopedia (Arabic Version) 2nd. Eds. Modern Book World Publication, Jordan. pp. 425.
[3] **Al-Ani F.K.** (1999). Epizootic lymphangitis in horses: a review of the literature. Rev. Sci. Tech. Off. Int. Epiz. 18: 691-699.
[4] **Al-Ani F. K., Younes O. F., and Al-Rawashdeh O.** (2002). Ringworm infection in cattle and horses in Jordan. Acta. Vet. Bron. 71: 55-60.
[5] **Al-Ani F.K., Sharrif L.A., Al-Rawashdeh O.F., Al-Qudah K. and Al-Hammi Y.** (1998). Camel diseases in Jordan. Proceedings of the 3rd Ann. Meet. Anim. Prod. Arid Condition. 2-3 May, 1998, Al-Ain, United Arab Emirate University. 2: 77-92.
[6] **Al-Ani F.K., Al-Bassam L.S. and Al-Salahi K.A.** (1995). Epidemiological study of dermatomycosis due to Trichophyton schoenleinii *in camels in Iraq. Bull. Anim. Hlth. Prod. Afr. 43: 87-92.*
[7] **Alhendi A.B., Alhizab F.A., Mohamed G.E. and Hatem M.E.** (1998). A note on ringworm in camel (Camelus dromedarius*) in Saudi Arabia. J. Camel. Pract. Res. 2: 249-250.*
[8] **Bhatia K.C., Kulshreshtha R.C. and Paul Gupta R.K.** (1983). Pulmonary aspergillosis in camel. Hyryna Vet. 20: 118-119.
[9] **Bizimana N.** (1994). Traditional Veterinary Practice in Africa. Gesellschaft fur Technische Zusammenarbeit (GTZ), Eschborn, Germany. pp.15.
[10] **Boever W.J. and Rush D.M.** (1975). Microsporum gypseum *infection in a dromedary camel. Vet. Med. Small Anim. Clinic. 70: 1190-1192.*
[11] **Channdel, B.S. and Kher H.N.** (1994). Occurrence of histoplasmosis-like disease in camel (Camelus dromedarius*). Indian Vet. J. 71: 521-523.*
[12] **Chatterjee A., Chaktaborty P., Chattopadhyay D. and Sengupta D.** (1978). Isolation of Trichophyton schoenleinii *from camel. Indian J. Anim. Health. 17: 79-81.*
[13] **El-Khouly A.B., Gadir F.A., Cluer D. and Manefield G.W.** (1992). Aspergillosis in camels affected with a specific respiratory and enteric syndrome. Aust. Vet. J. 69: 182-186.
[14] **El-Timawy A.M., Seddik I. and Atia M.** (1988). Camel ringworm in Upper Egypt. Assiut Vet. Med. J. 20: 53-59.

[15] **Evans J. Simpkin P. and Atkins D.** (1995). Camel keeping in Kenya, Range Management Handbook of Kenya. Volume III, Livestock Development and Markting, Ministry of Agriculture, Nairobi, Republic of Kenya. pp.8-9.
[16] **Fadlelmula A., Agab H., Horgne J.M. et. al.** (1994). First isolation of Trichophyton verrucosum *as the etiology of ringworm in Sudanese camels. Rev. Elev. Med. Vet. Pays. Trop. 47: 184-187.*
[17] **Fischman o., Siguera P.A., and Baptista G.** (1987). Microsporum gypseum *infection in a grey wolf (Canis lupus*) and a camel (Camelus bacterianus*) in a zoological garden. Mycosen. 30: 295-297.*
[18] **Fowler M.E., Pappagianis D. and Ingram I.** (1992). Coccidiodomycosis in llama in the United States-19 cases (1981-1989). J. Am. Vet. Med. Ass. 201:1609-1614.
[19] **French R. A. and Ashworth C.D.** (1994). Zygomycosis caused by Conidiobolus coronatus *in a llama (Lama glama*). Vet. Pathol. 31: 120-122.
[20] **Gareis M. and Wernery U.** (1992). Determination of mycotoxins in samples associated with cases of intoxications in camels. Proc. 1st. Int. Camel Conf. 2-6 February, 1992, Dubai. pp. 403-404.
[21] **Gitao C.G.** (1992). Dermatophilosis in camels (Camelus dromedarius*) in Kenya. Rev. Sci. Tech. Off. Int. Epiz. 11: 1079-1086.*
[22] **Gitao C.G., Agab H. and Khalifalla A.J.** (1998) An outbreak of a mixed infection of Dermatophilus congolensis *and Microsporum gypseum* in camel (Camelus dromedarius*) in Saudi Arabia. Rev. Sci. Tech. 17: 749-755.*
[23] **Gupta P.K., Singh R.P. and Singh I.P.** (1970). A study of dermatomycosis ringworm in domestic animals and fowls. Indian J. Anim. Hlth. 9: 85-89.
[24] **Hajsig M., Naglio T., Hajsig D. and Herceg M.** (1985). Systemic mycoses in domestic and wild ruminants. 1. Candidiosis of forestomachs in the lamb, calf, kid and newborn llama. Vet. Arch. 55: 53-58.
[25] **Holmes L.A., Frame N.W., Frame R.K., Duff J.P. and Lewis G.C.** (1999). Suspected tremorgenic mycotoxicosis (ryegrass staggers) in alpacas (Llama pacos*) in the UK. Vet. Rec. 145: 462-463.*
[26] **Khamiev S.K.** (1981). Clinical signs of ringworm in bactrian camels and dromedaries. Veterinaria. 7: 38-39.
[27] **Khamiev S.K.** (1985). Ringworm in camels and its control. Vestnik-Sel. Skokhozya. Nauli. 1: 133-135.
[28] **Khouly A.E., Gadir F.A., Cluer D.D. and Manefield G.W.** (1992). Aspergillosis in camels affected with a specific respiratory and enteric syndrome. Aust. Vet. J. 69: 182-186.
[29] **Kramer J.W., Bowman D., Parish S. and Tumas D.** (1994). What is your diagnosis? (Idiopathic fungal pleocytosis in a llama)). Vet. Clinic. Pathol. 23: 2, 37 & 46.
[30] **Kuttin E.S., Al-Hanaty E., Feldman M., Chaimovits M. and Muller J.** (1986). Dermatophtosis of camels. Rev. Med. Mycol. 24: 341-344.
[31] **Langner C.** (1995). Microsporum canis *infection in a Bactrian camel (Camelus bactrianus*). A case report. Zoolo. Garten. 65: 207-208.
[32] **Le Net J.L., Ahmed M.F., Saint-Martin G., Masson M.T., Montois C. and Longeart L.** (1993). Granulomatous enteritis in a dromedary (Camelus dromedarius) due to green algal infection. Vet. Pathol. 30: 370-373.
[33] **Mackintosh C. and Orr M.** (1993). Ryegrass staggers in alpacas. Vet. Rec. 132: 120-122.
[34] **Mahmoud A.L.** (1993). Dermatophytes and other associated fungi isolated from ringworm lesions of camels. Folia Microbiologica. 38: 505-508.
[35] **Mancianti F. Papini R. and Cavicchio P.** (1988). Microsporum gypseum dermatomycosis in a bacterian camel (Camelus bactrianus). Annalidella Facolta. Med. Vet. Pisa. 41: 233-237.
[36] **Marvin-Sikkema E.D., Lahpor G.A., Kraak M.N. Gottschal J.C. and Prins R.A.** (1992). Characterization of an anaerobic fungus from llama feces. J. Gen. Microbiol. 138: 2235-2241.
[37] **McGrane J.J. and Higgins A.J.** (1985). Infectious diseases of camel: virus, bacteria and fungi. Br. Vet. J. 141: 529-547.
[38] **Moll H.D., Schumacher J. and Hoover T.R.** (1992). Entomophthormycosis condidiobolae *in a llama. J.Am. Vet. Med. Ass. 200. 969-970.*
[39] **Muir S.** (1982). Coccidioidomycosis in the llama: case report and epidemiological survey. J.Am. Vet. Med. Ass. 181: 1334-1337.
[40] **Muntz F. H.** (1999). Oxalate-producing pulmonary aspergillosis in an alpaca. Vet. Pathol. 36: 631-632.
[41] **Orr M.B.** (1990). Ryegrass staggers in alpacas in New Zealand. Surveillance. 17:4.
[42] **Osman N.A.** and Abdel-Gadir F. (1991). Survey of total aflatoxins in camel sera by enzyme-linked immunosorbent assay (ELISA). Mycotoxin Res. 7:35-38.
[43] **Pickett J.P., Moore C.P., Beehler B.A. et al.** (1985). Bilateral chorioretinitis secondary to disseminated aspergillosis in an alpaca. J. A. Vet. Med. Assoc. 187: 1241-1243.
[44] **Polyakov I.D. and Ivanov L.G.** (1985). Clinical menifestations and differential diagnosis of ringworm in camels. Bull. Vses. Inst. Eksp. Vet. 59: 64-66.
[45] **Purohit N.R., Purohit R.K., Chouhan D.S., Choudhary R.J. and Sharma K.N.** (1988). Suspected cutaneous actinobacillosis in camels. Aust. Vet. J. 65: 31-32.

[46] **Quinn P.J., Carter M., Markey B. and Carter G.** (1994) Clinical Veterinary Microbiology. 1st. Eds. Wolfe Publication, London.
[47] **Saad A.M., Abdelgadir A.M. and Moss M.O.** (1989). Aflatoxin in human and camel milk in Abu Dhabi, United Arab Emirates. Mycotoxin Res. 5: 57-60.
[48] **Sarkisov A.K., Polyakov I.D. and Ivanova L.G.** (1989). Dermatomycosis of camels and biological properties of the causal agent. Veterinarariya 10: 31-35.
[49] **Satir A.A., Abu Bakr M.I., Abalkheil A., Abdel Ghaffar A.E. and Babiker A.E.** (1993). Phycomycosis of the abomasum in Camelus dromedarius. *J. Vet. Med. Ass. 40: 672-675.*
[50] **Servero L.C., Bohrer J., Geyer G.R. and Ferreiro L.** (1989). Invasive aspergillosis in an alpaca (Lama pacos*). J. Med. Vet. Mycol. 27: 193-195.*
[51] **Singh M.P. and Singh C.M.** (1969). Mycotic dermatitis in camels. Indian Vet.J. 46: 854-856.
[52] **Spesivtsevia N.A. and Noskov A.I.** (1959). Epizootic lymphangitis in camels. Trudy Vses Institute Vet. Sanit. Ectopar. 14: 86.
[53] **Woolums A.R., DeNicola D.B., Rhyan J.C. *et al.*** (1995). Pulmonary histoplasmosis in a llama. J. Vet. Diagn. Invest. 7: 567-569.

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Role and Method of Advising for Producers in Natural Hardship Conditions

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Abstract. Economy of Kyrgyzstan and majority of kyrgyzstanee depend on agriculture. Both poor and well-off people earn their living by farming and livestock breeding. The problems that they face in agricultural production are far from being resolved, but have tremendous and still not identified potential for farmers. The «Rural Advisory Service» (RAS) established in Kyrgyzstan can render such services as help in problems resolution, spread knowledge, new ideas and information essential for farmers. RAS offers training for farmers in their interested topics, adaptive researches, group formation, individual and group consultations, exhibitions and different campaigns.

RAS is closely collaborating with many programs the objectives of which are aimed at efficient and viable management of natural resources and establishment of reliable and adequate infrastructure as basis for economic and social development. One of them is Central Asian Mountain Partnership (CAMP) "Efforts integration for sustainable support of mountainous regions". Within framework of this collaboration CAMP and RAS have found common activity which is aimed at *support and spread of the best examples of water and soil use through training activities of the Extension services for farmers; collaboration with WOCAT (the world review of soil and water saving technologies).*

RAS and CAMP conduct training activities for farmers and rural inhabitants on soil and water saving technologies collected by WOCAT in Kyrgyzstan, Kazakhstan and Tajikistan. At the conference in Ashgabat out of 40 technologies may be the following ten will be presented:

- Preservation of warmth and moisture in soil in growing of ecologically safe agricultural products by thermostatic method (Kyrgyzstan)
- Technology of biohumus receiving (Kyrgyzstan)
- Bottle watering of vegetables and melons and water-melons (Kyrgyzstan)
- Irrigation of difficult of access plots for self-flowing irrigation water with the help of hydraulic pump of the «Hydrotaran» type (Kyrgyzstan)
- Pasture rotation for sheep (Kyrgyzstan)
- Reclamation of stone land for orchard (Kyrgyzstan)
- Minimum treatment of soil for cereals growing (Kazakhstan) lands.

Introduction

Economy of Kyrgyzstan and majority of kyrgyzstanee depend on agriculture. Both poor and well-off people earn their living by farming and livestock breeding. The problems that they face in agricultural production are far from being resolved, but have tremendous and still not identified potential for farmers. The «Rural Advisory Service» (RAS) established

in Kyrgyzstan can render such services as help in problems resolution, spread knowledge, new ideas and information essential for farmers. RAS offers training for farmers in their interested topics, adaptive researches, group formation, individual and group consultations, exhibitions and different campaigns.

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1. Maintaining Soil Fertility: Technology for Producing Bio-Humus

1.1. Problems

The main problems are low soil efficiency, stony earth and lack of rainfall and steeply stopping land. Other problems are low natural efficiency of soil together with very stony soil location in the basin of an ancient river. Low yield of cultivated crops, big expenses for gathering stones and cutting terraces on the land plot.

1.2. Solution

The owner of the farm Blohin Oleg Vasiyevich decided to increase the yield of his land plot using bio-humus produced using Californian rain worms.

2. Description of SWS Technology: Technology of Acquiring Bio-Humus

Blohin O. V. purchased 0.5 kg of Californian red rain worms and released them into a concrete silo he had chosen beforehand. It is 1.5 m high, 1 m wide and 2 m long. Before he released the worms into the pool he put them into a 0.25 m high trench with plant waste. After 14 days the trench was filled with compressed weeds, which were cut from the land plot and slightly watered. The time for filling the trench with worms was the beginning of August. The height of the plant waste in trench decreases every month, this is why the trench is filled with plant waste once again and covered with a wooden cover. The cover is taken off in the spring when the weather becomes stably warm and the trench is filled with fresh manure. In May 80% of the silo's volume is a ready to use organic substance called bio-humus. The substance's properties are similar to humus. The chemical composition of this substance makes it a good fertilizer that contains 7.5% nitrogen, 8.4% phosphate and 9% potassium. Moreover the bio-humus contains micro-elements and active soil microorganisms, which increase soil fertility. The substance is laid out on a metal net (a net from an old bed could be used) and exposed to the sun's rays in order to separate the bio-humus from the worms. Fresh manure is laid underneath the net. Some time later the worms move to the manure leaving ready bio-humus on the net. In May, the farmer can already use the bio-humus before planting vegetables and for fertilizing the soil. It is used in a ratio of

5 m/hectare while ploughing and for inter-row segments 300 kg/hectare and it is earthed up immediately. It is better to use it as a fertilizer when the soil has been suitably watered and it is also recommended to water the soil after using bio-humus.

2.1. Results

Methods of utilising the technology: Oleg Vladimirovich Blohin learned about the existence of California red rain worms through TV and purchased 0,5 kg from the breeders. He started testing the worms on his own farm in summer 2002 and in 2003 he was already using the bio-humus as a fertilizer for vegetables.

Using the technology: This technology has been used by American farmers since the 1970s for cultivating organic products. This technology has been used in Kyrgyzstan since 1995 in the experimental farm facility owned by the institute of Agriculture in Djal village, on the Alga Joint Farm in Issyk-Ata rayon and on the Orgochor farm of Djeti-Oguz rayon.

2.2. Spreading Opportunities

Bio-humus is used on the Alga farm and the KIZ experimental farm. Blohin's neighbours have purchased some red Californian rain worms for breeding.

2.3. Benefits

Currently, due to the high cost of mineral fertilizers, growers are more frequently starting to use organic fertilizers. Utilization of bio-humus is very profitable for cultivating organic produce. Moreover it restores the natural micro-biological activity of the soil. Utilizing bio-humus as primary fertilizer for ploughing increases the tomato yield by 23% and used as additional fertilizer 10-12%. The level of profitability of utilizing bio-humus is 116-224%.

3. Strengthening Slopes and Soil Surfaces: Technology for Growing Protective Rows of Plants to Combat Wind Water Erosion

3.1. Problems

Losses of biological variety, decreasing pasture yield and degradation of saxaul ecological systems.

4. Regulating the Run-off of the Syrdariya River, Decreasing Water Supply to the Delta and Increasing Desertification

Decreasing water table levels, increasing salinity, denuding and accumulating processes.

4.1. Solution

Planting rows and blocks of various types of trees and bushes of local origin.

Description of SWS technology: growing protective rows of plants to combat wind and water erosion. Farmer Bakyt Isaev planted a total of hectares of saplings of saxaul, tamarisk, karabarak, and sarzan on denuded soil with destroyed vegetation cover. He dug up 2-3 year old saplings from natural copses (on the dried up seabed of the Aral Sea and on worth-

less land in the delta) and then re-planted them by hand. Planting was carried out in late autumn or early spring. On alluvial-meadow desert soils he planted haloxylon, on normal and meadow salt soils he planted tamarisk, karabarak and sarzan. Haloxylon and tamarisk saplings were planted in two rows 0.5 metres apart in rows or blocks, in furrows or holes with a depth of 40-50 cm; the width between rows and blocks in 4-5 metres. At the same time, in the spaces between the rows he sowed bushes and grass. Seedlings of karabarak and sarzan were planted in one row; using the same system as with the haloxylon. The distance between seedlings (saplings) in both cases does not exceed 1.5-2.0 m, 2 m apart and the length of rows is different and depends on he size of a denuded land plot, but anyway, did not exceed 200 m. To prevent the seedlings from being blown down, special counter-denudation covering mats and fascines from reeds and canes were applied. They were handmade in water meadows of the Syrdariya River. For better rooting each seedling was watered with 5-10 litres of water.

4.2. Results

Methods of utilizing the technology: Farmer B. Isaev grew protective rows of plants to combat wind and water erosion based on recommendations developed by National Production Centre of the Forestry Industry (Candidate of Agricultural science V. Kaverin).

4.3. Opportunity for Spreading

This technology is widely applied in ecologically disable manmade use regions located in the desert zone (oil-gas fields and gas and oil products).

Growing remedial plantations in desert and semi-desert zones decreases water and wind erosion within 2-3 years. The high level of seedlings rooting (40-60%) increases the productivity of pastures, improves the microclimate, creates favorable conditions for vital functions of the local fauna and promotes the restoration of saxaul ecological systems.

The technology is simple to use, does not require monetary and labor expenses and is recommended for widespread application.

5. Improving Water Potential in Soils: Minimum Soil Treatment of Sowing of Wheat and Barley

5.1. Problems

Preserving moisture in the soil, compressing soil levels and struggling against weeds. Absence of mineral fertilizers, low incomes of the farm's members. Decreasing grain crop yields.

5.2. Solution

Applying minimum soil treatment to sowings of grain crops to increase crop yield and reduce general expenses.

Description of SWS technology: *minimum soil treatment of sowings of wheat and barley.* Just after harvesting his grain crops, farmer Alexey Kalmakov applies mineral fertilizers and then immediately carries out small-scale field works by harrowing to a depth of 6-8 cm. In spring, from May 18-30th, he sows his grain crops (wheat and barley) using seed drills and then, when necessary, he treats the soil with herbicides, fungicides and insecti-

cides. The farmer applies grain-fallow crop rotations, and lets 25% to 33% of arable land lay fallow, which he treats with Raundan, a chemical weed killer. When treating the fallow area with Raundan this attacks longstanding cereal and dicotyledonous weeds including the surface parts and roots. It is impossible for the weeds to grow back through their root systems and the plants die in 5-10 days. He sprays only for vegetating weeds. The norm is 2-3 liters per hectare. The optimum height of the weeds is 25-30 cm. When the weeds are taller, the norm for the poison increases. Fallow land that is to be treated with Raundan, with the purpose of sealing the weed seeds in the soil, is disk harrowed in autumn. Easter calendar dates for fallow land chemical weeding are from July 18-30th. Under minimum treatment the farmer pays special attention to the problem connected with compressing soil horizons. Sowing grain crops after harrowing only gives good harvests for 3-4 years and by the 5-6th year the crop yield decreases. That is why he has harrowed only once in the last 3-4 years thus decreasing expenses for growing grain crops.

5.3. Results

Methods of utilizing the technology: The farmer got the minimum soil treatment for sowing wheat and barley from periodic scientific-populace literature and introduced in onto his farm. The technology is implemented by the 7 family members.

5.4. Opportunity for Spreading

At present this technology is widely applied in the moderately dry steppe zone of Kazakhstan where usual chemozems (black soils) and dark-chestnut soil predominate. Using minimum soil treatment of sowings of wheat and barley reduces expenses by 3 times: gives better yields up to 21 centners per hectare on land laying fallow and 10.5 centners per hectare on stem: improves the agro-melioration characteristics of soil: decreases compression of the soil cover and improves airing.

6. Reinforcing Slopes and the Surface of Soil: Fencing off Pasture Land and Forest Plantations

6.1. Problems

Shortage of land, low yield of natural pastures, the pasture are overloaded with cattle and heavy erosion is taking place near the populated areas.

6.2. Solution

To achieve the effective use of pastures the farmer has fenced off 0,5 hectares of pasture. *Description of the SWS technology: fencing off pasture land and forest plantations.*

To fence off pasture the farmer used different old metal and wooden posts with wire netting between them. The height of the fence is a meter and a half. After fencing it off, Sh. Aliev cut terraces on the slopes using the Khashar method (the work performed by a community and for the community free of charge). On the created terraces he subsequently planted grapes, apricots and oleaster. When planting each tree he added organic mineral fertilizers into the holes. For the first three years he carried out additional irrigation to help the saplings take root. Water for irrigation was brought up in rubber tubes on donkeys. The land was irrigated during July and August. The farmer uses a part of the plot for haymaking. The crop capacity of the grass is 7-8 centners of dry hay per hectare. This makes it possible for the farmer to keep milking animals.

6.3. Results

Compared to the neighboring plots the growth of the slope on this plot of land improved and the top soil was fortified. The farmer additionally gathers in a harvest of fruit and hay for the cattle.

This technology reduces erosion and improves soil fertility.

6.4. Disadvantages of the Technology

Creating a garden requires additional financial and material expenses.

7. Increase of Water Content in Soil: Stone Terraces a Traditional Method of Mountain Land Improvement

7.1. Problems

- Shortage of land in mountain areas of Tajikistan, with 0.01 hectares of land per capita.
- Land of mechanized means of land improvement and for ploughing plots.
- Land erosion and degradation.

7.2. Solution

Description of the SWS technology: stone terraces a traditional method of mountain land improvement.

Stone walls 1-1,5 and sometimes 2,0 m high are built on mountain slopes depending on the local gradient. After that the slope is partially leveled and manually covered with melkozem. Dung, rubbish and ashes are introduced into the soil, mixed with soil by spade and watered for the soil to be prepared for sowing. Then sowing of luceme begins. For 3 years the physical and water properties of the soil improve. Subsequently potatoes, vegetables and cereal crops are grown on this land.

7.3. Results

During the first year the farmer earned 100-200 somoni from 1 hectare and subsequently his income increased to 500-700 somoni.

Compared to the neighboring plots, the use improvement of the new land is more effective. Compared to the previous period, better crop yield was observed and greater income was received from growing agricultural crops. It is possible to grow a bigger number of crops. This technology helps to prevent soil erosion.

7.4. Advantages of the Technology

Improvement of land on steep mountain slopes with the help of local materials.

7.5. Disadvantage of the Technology

Annual repair of stone terraces.

The technology can be used everywhere in mountain and sub-mountain zones of Tajikistan to create additional irrigated arable land and use it effectively. The technology is simple, cheap and easily accessible.

8. Strengthening Slopes and Soil Surface: Rotating Sheep Pastures

8.1. Problems

Irrational utilization of hayfields and pastures. Pasture soil erosion if pasture rotation is not applied. Absence of experience and skills in pasture development. Lack of knowledge concerning growth, development and quality peculiarities of forage grass growing on the slopes of various direction and height above sea level.

Decreasing yield and quality of forage grass. Decreasing opportunities for using mountain pastures.

8.2. Solution

An opportunity to introduce pasture rotation for shepherding in highlands occurred after the collapse of the collective farm. This is why the farmer decided to apply pasture rotation in order to restore the flora of the hayfields and pasture and use them for grazing the sheep according to their seasonal growth and development.

Description of SWS technology of sheep pasture rotation.

The technology is being used at the Chet-Koy-Suu Riverbasin's source. The technology consists of several components, these are: a) pastures, b) organizing a water trough/pond, c) supplying the sheep with forage salt.

The first pasture is in Janaydyn Jantygy. The farmer erects his tent June,when he comes up from the valley. The pasture is located 2,100 m above sea level. The sheep feel very comfortable here, after moving from the valley where the weather is hot. There are also free water springs. The sheep are pastured for 15 days in this area. The second part of the pasture is located in nearby Bayboo-Bulak. It is 2,100-2,500 meters above sea level. The surface of the pasture is almost entirely covered with grass. The sheep are pasture on the kobreznevyh meadows of Dootu-Uushkura. Whilst pasturing here for 10 days the sheep get fat and their wool grows faster after they are shorn. The sheep are moved to the third part of the pasture, which is located at the source of the Chet-Koy-Suu River, at the beginning of July. The air is fresh and the sheep graze all the time, not gathering in flocks as happens in the lower zones if the sheep are pasture there during this period. The sheep fatten up quickly and almost never get ill.

The fourth part of the pasture is located at the mouth, source and middle part of Kashka-Tera, which is, in turn, located east of the pasture the sheep continue gathering/accumulating fat and desperately need forage salt and water. The sheep are moved to Kashka-Ter in the middle of July and pastured there for 15 days. At the beginning of August the herd is moved back to the source of the Chet-Koy –Suu and pastured there for another 10 days. In the middle of August the sheep are moved to the source of the Bayboo-Bulak to be pastured for 10 days. During the last 5-6 days of August the sheep are again grazed on the first pasture in Janaydyn-Jantygy before they are moved back to their valley area of Issik-Kul. The sheep look very good at this time, they graze less and spend more time lying on the ground and the breeding season has come by then.

8.3. Results

Methods of utilizing the technology: Pasture rotation was used in this mountain area backing soviet times, when the number of sheep was 5-6 times greater than now. Asangaziev Suyunbek, together with his brother Jekshey, have pasture two sheep herds in this area. They have arranged to split the Bayboo Bulak and alpine meadow areas into smaller parts and applied pasture rotation technology. The herd decreased sharply after 1995 and only 2

herds are left from the 5-6 herds bred previously. The farmer registered a rental contract for the pastures and introduced the pasture rotation technology described above. This technology is also used by other farmers, Abykeev M. and Dusheev E., who also pasture animals in the Chet-Koy-Suu riverbasin.

8.4. Opportunity for Spreading

This technology is applicable on all pastures in Kyrgyzstan in order to increase efficiency and restore natural mountain pastures. It is very traditional for mountainous Kyrgyzstan and used even before the soviet period.

8.5. Benefits

Pasture erosion stopped when utilizing this technology, pasture yield increased and inedible toxic grasses are being removed from the pastures. The sheep become fatter as a result of the increased pasture yield. Twin sheep are born more frequently than before.

9. Strengthening Slopes and Soil Surface: Turning Stony Ground into Orchards

9.1. Problems

- Low yield of cultivated land.
- Stony soil and dry climate.
- Low yield of field crops and necessity of irrigating agricultural crops.

9.2. Solution

Issyk-Kul mechanized forestry unit decided to adapt stony desert steppe between the highway and the mountains and lay an orchard, in 1986-87.

Description of SWS technology: turning stony ground into an orchard.

The area was leveled and marked out beforehand. Then 25-30 cm deep trenches, 4 cm apart were made using T4 and C-100 tractors with heavy chisels attached to them. Later, 30 cm deep holes, 3 meters apart along the trenches were dug using a small geological bore-machine installed on a GAZ 66. Then the inhabitants of Orkon village planted semi-dwarf apple and apricot tree saplings. 20 litres of water were poured into each hole before planting the saplings. Then the orchard was irrigated with water from the Chet-Koy-Suu River every 10 days. Water-reserve forming irrigation, using 800-900 m^3/hectare, was conducted annually in November.

There is a protecting line of poplars on the western side of the orchard, which stops the wind.

The orchard started bearing fruit at the beginning of the 90s and the forestry department gave it to the Kart Marx collective farm in 1995. The collective farm grew 100-150 centners/hectare of apples of apples and apricots depending on the year.

The orchard was divided into parts and given to Ornok village inhabitants in 1998, due to the collapse of the collective farm. People started cultivating their shares on their own using an agricultural technique common in this zone. One irrigation session using 600 m^3/hectare is conducted in spring before sprouting. After the fruits start appearing the orchard is sprayed against insects in a massive and organized way. After chemical disinfections, the orchard is irrigated using 600-700 m^3/hectare 3 times during the growing season.

2-3 years after dividing the orchard up the farmers started to get good apple harvests: 80-100 centners/hectare. After harvesting or leaf-fall, water-reserve forming irrigation is conducted using 800 m^3/ectares.

Only horses are pastured on the orchard in winter since they do not damage the trees. Cows, sheep and goats are not pasture.

9.3. Results

Method of executing: The inhabitants repaired the destroyed fence around the orchard in 1998 and employ a gardener and irrigator. Every family pays for those services in harvested fruit.

Utilizing the technology: This SWS technology was introduced in the 50s. Such orchards can be found in the following villages: Kyzyl-Oruk, Chok-Tal, Chon-Sary-Oy, Kara-Oy in the Issyk-Kul rayon. This technology is being used by new settlers who build new houses and take up farming.

Spreading opportunities: This SWS technology is currently applied while cultivating new land, building resorts on Issyk-Kul's shore and building private houses.

9.4. Benefits

Opportunities for agricultural utilization on very stony soils in pre-mountain areas. Besides, meadow grasses appear between the rows And can be used as forage for livestock. The fruit harvested in this orchard is high quality, tasty and affordable. The members of the community receive good incomes from selling the fruit.

10. Decreasing Moisture: Preserving Heat and Moisture in the Soil while Growing Ecologically Safe Agricultural Produce Using the Thermostatic Method

10.1. Problems

Poor variety of agricultural products. The low level of natural efficiency of the soil, high of irrigation-caused erosion and stoniness of the land and lack of heat and natural moisture. There has been a steep decline in the harvest and quality of the cultivated crops and the grain yield is only 10-12 centers/hectare. Low humus level/composition and low level of minerals in the soil and low moisture absorbing capacity or "dryness" of the soil. The arable lands are located in steeply sloping areas and have root soils mixed with sand. Most of the canal irrigation system that provides half of the irrigation water to the fields are out of order or have been destroyed. Short vegetation season.

Local farmers incur lag expenses gathering and getting rid of the stones from the fields. Unregulated watering on the sandy soil has led to high levels of soil erosion. Almost half of the upper fertile layer of soil has been washed away.

It has become impossible to grow vegetables on a commercial scale. The fruit harvest is not stable from year. The income of the farmers from agriculture has decreased by 30-40%.

Some land plots are heavily polluted due to the use of chemical pesticides in the past and agricultural products grown on such land are unfit for consumption.

10.2. Solution

The surface of the land is covered with polyethylene film and methods of local irrigation are being used in order to save irrigation water and to preserve the soil moisture and heat

are in short supply. The so-called thermostatic method is being used in order to accelerate the growth of the vegetables.

Description of SWS technology: preserving heat and moisture in the soil while cultivating ecologically safe agricultural produce using the thermostatic method.

The land plot was irrigated and ploughed to a depth of 20 cm and then harrowed at the beginning of autumn and winter wheat was planted there in the middle of autumn. During the warm autumn of 2002 the plants developed well, sprouted well and met the winter in good condition. In the spring, at the end of April, the thick green mass of wheat was cut down spread all over the pilot surface. Then the ground up mixture of wheat was earthed up into the soil having been simultaneously loosened using a BDT-3 model heavy disk harrow and as wheeled tractor. The green mixture preserves the moisture and simultaneously enriches the soil. After the sun gets strong enough and air temperature becomes stable enough the external layer of polyethylene film is taken off in the daytime and put on again at night. Later the sheeting is taken off completely and kept until next year. In order to preserve the sheeting so that it can be used for several years. It is put into another polyethylene packet and buried in the earth where the direct sunrays cannot penetrate.

10.3. Results

Methods of utilizing the technology: the Dolnara-Hannon Public Association has been using technology since 2001. The described method is used for cultivating various vegetable and melons including tomatoes, cucumbers, pumpkins, water-melons, melons, sorghum, batat (sweet potato) and other. The fields are harvested 20-25 days earlier than normal in this area, almost at the same time as in the Chui Valley.

Opportunity for spreading this technology:

It is recommended for agricultural lands of Central Asia that lack water and have a short growing season. It is primarily recommended for vegetables and melons. Erosion decreased sharply, soil efficiency increased significantly and more irrigation water is being saved. Some 7-8 irrigation sessions were necessary and 800-1000cubic metres of water were used before the SWS technology started being used to cultivate the vegetables however, after introducing this technology the number of necessary irrigation sessions tell to 3-4 with water use of only 100-120 cubic metres per session.

The grain yield increased from 12-15 to 40 centners/hectare and vegetables to 200-250 centners/hectare. It was also possible to sell the vegetables for a much higher price due them being harvested earlier.

11. Irrigation Technology: Bottle Irrigation of Vegetables and Melons

11.1. Problems

High level of soil dryness, as a result of which the soil erodes (I mean the furrows etc. disappear) quickly and become covered by a hard layer. Field crop yields have decreased by 25-30%. The soil of the field is sandy and loamy carbonate sediment and the soil structure leads to intensive evaporation of moisture from it. Lack of irrigation water, stony soil, summer dryness of soil and air strong hot winds. Low water-holding/water-retaining capacity of the soil. Soil erosion.

11.2. Solution

Utilizing subsoil irrigation using plastic mineral water bottles.

Description of SWS technology: bottle irrigation of vegetables.

Kopsharova N. collected 1 and 1,5 liter plastic bottles and maid small holes on three sides 5 cm above the bottom, in the center and upper part and the bend of the bottles. The holes were made so that two hours would pass before the water ran out. She put 1 spoonful of ammonium nitrate in the bottom of each bottle. The bottle was buried in soil prepared beforehand, as deep as tomato and melon roots spread, so that the mouth of the bottle appears on the surface. Tomato and watermelon seedlings were planted 10-15 cm apart around the buried bottle. The bottle is completely filled with water and is closed tightly by a cover. The bottles are filled with water 2-3 times a day before the seedlings grow stronger. Later the bottle are filled once a day. The ammonium nitrate, which was put into the bottles, dissolves slowly and steadily penetrates into the soil, thus feeding the plant throughout the vegetation season.

11.3. Results

Methods of utilizing the technology: Kopjasharova N. got the bottles irrigation method from a scientific magazine and decided to test it on her farming plot. The technology is applied and all family members take part in it.

Using the technology: the given technology is already being used large areas of melon plantation in zones of desert agriculture in Central Asian countries and the Middle East, and is possible in dry oblasts of Central Asia, primarily in farming plots attached to houses.

11.4. Benefits

Soil erosion ceases due to sub-soil irrigation and inefficient water losses decline sharply and hard surface soil layer does not occur. Yield increases due to the fact that the soil surface remains dry the fruit touching the earth are not destroyed by slugs. This technology does not require large expenses and is recommended to the applied on small fields, primarily for melons.

12. Irrigation Technologies: Irrigating Areas that are Difficult to be Reached by Free Flowing Water, Using a Hydrotaran Hydraulic Pump

12.1. Problems

There is a severe lack of irrigated land in the Djail Ayil Okmotu area. There are only 0.13 hectares of irrigated land allocated for each member of the Imankulov family. Moreover, the main land plot is located on the outskirts of Manas Villige, 25 km away from where the family lives.

The farmland is located on northern and southern slopes, with an angle of 15-18^{o}. the soil is low yielding, subject to slippage and drying up and there is a problem of transportihg free flowing irrigation water.

The land is located in sloping, undulating terrain and the slopes are 15-18^{o}. The soil is weakly structured forest-like loamy soil, which is easily washed away by rain.

12.2. Solution

Imankulov Samarkul desided to pump water to 0,48 of land that is difficult to be reached by free-flowing water, using a Hydrotaran hydraulic pump.

Description of SWS technology: irrigating areas that are difficult to be reached by free flowing water, using a Hydrotaran hydraulic pump.

The Hydrotaran hydraulic pump, model GT-100, is attached to a rectangular metal frame 1.5x2.5 m, built over a canal with a fast water-flow. The flow speed is 3,5 m/sec. there is a 150 mm diameter, 4 m long supply pipe attached to the pump. The end of the pipe is inserted into the water. The pump has an installed valve made of conveyer belt. The cylinder to which the feeder pipe is attached is on the top of the pump. The pipe that supplies the water directly to the field is attached to that feeder pipe.

The water that gets to the supply pipe from the water-flow accelerates up to the speed of the water-flow itself and closes the valve due to pressure. At this moment there is excessive pressure created in the cylinder that forces the water to flow into the pipe supplying it to the field. The water is supplied to the field from the supply pipe in pulses. The speed of water-flow is enough to supply the water to a height of 8 m and a distance of meters. The water is supplied in pulses and each pulse brings 1-1.5 liters of water with a time interval of 2-3 seconds. Using this method of irrigation the water does not wash away the furrows and there is an opportunity to penetrate into the soil evenly, so soil erosion is reduced.

12.3. Results

Using the technology: the hydraulic pump has been successfully used on Imankulov's farm since 2000.

12.4. Spreading Opportunities

The Hydrotaran hydraulic pump is currently being successfully used for irrigating dry land, watering orchards and vineyards on farm and ordinary domestic farming in the following villages.

The Hydrotaran is being successfully used in desert and semi-desert zones in Kazakhstan.

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Factors Affecting Reproductive Performance of Camels at the Herd and Individual Level

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Abstract. Camels are known to outperform any other species under severe climatic and nutritional stresses however several by biological and pathological factors are involved in overall camel reproductive efficiency. The present paper summarizes our state of knowledge regarding camel reproductive efficiency and factors affecting it.

Amongst the biological limitations to reproductive efficiency in camels, late onset of puberty in both the male and the female and long lactation anoestrus are probably the most commonly cited. Age at first parturition and interval between parturition varies from 36 to 71 months and from 17.5 and 51 months, respectively. The great variability of these reproductive parameters suggests implication of several other factors that remain unstudied such as nutritional level, breed differences and health. Selection and better nutritional management can achieve improvement of these parameters. Inter-calving interval is improved tremendously by early weaning. Average number of days between weaning and mating is 7 to 20 days.

Pregnancy rate (or conception rate) or birth rate of females in reproduction and varies 12% to 85%. The most common components of poor fertility are increased early pregnancy loss and abortion, which may be as high as 40%. Substantial advances have been made in recent years on the methodology of diagnosis (ultrasonography, culture and biopsy) and treatment of cause of infertility and reproductive losses. Studies on causes of abortion and methodological approach for the study of reproductive losses are still lacking. Male infertility is also still poorly studied.

The last component of reproductive efficiency in camels is represented by high neonatal losses ranging from 10 to 90% of the calf crop in some situation. Causes of neonatal losses have been studied to some degree but merit further investigation.

Introduction

Reproductive management is the centerpiece of any animal production system. Tremendous progress has been made in the last 2 decades in our understanding of reproductive phenomena in camelidae and their interaction with the environment and disease processes. This knowledge should allow the veterinary practitioner and the breeder to work together to optimize production. Herd health management is a continuous process by which the veterinarian and the breeder monitor the herd in order to meet Production goals. The herd is evaluated through a set of indices, which are compared to production, and reproduction targets set according to physiological and economic criteria. This paper discussed camel reproductive performance at the herd as well as at the individual animal level, and the factors affecting this performance.

Table 1. Age at first calving in the dromedary camel.

Country	Age at first calving (months)	Reference
India	4 (years)	(37)
India	61.0 to.98	(21)
India	62 ± 1	(48) (49)
Kenya	54.2 ± 6.3 (45 to 70)	(100)
Kenya	48 ± 0.51 (45.6 to 71.3)	(44)
Kenya	58	(34)
Kenya	48± 10	(59)
Morocco	48+9	(29)
Morocco	49.4 ± 8.1	(71)
Niger	63	(62)
Niger	4.9 ±1.6* (years)	(99)
Somalia	7.7 ± 2	(15)
Tunisia	36-37	(55,56)
Tunisia	44	(41,42)
U. A .E.	55.3	(6)

1. Camel Herd Reproductive Performance and Factors Affecting it

The primary objective in any animal production is to obtain the maximum number of offspring from the reproductive herd. Thus, evaluation of reproduction is critical for the herd economics. Reproductive efficiency can be determined using several indicators, which address specific concerns. Reproductive performance of the herd can be measured using fertility indices, pregnancy loss as well as perinatal losses indices [82].

In camels, fertility indices may be determined by the annual reproductive rate (number of births in one year/number of mated females), reduplication rate, fecundity or conception rate [82]. In the dromedary, because of the average parturition interval of 2 years, the reduplication rate is 100% if 50% of the females give birth in one year [25].

Reproductive losses are generally estimated by the abortion rate, rate of culling for infertility reason, and rate of neonatal mortality.

Reproductive performance is also estimated based of specific reproductive interval amongst which the age at first mating and first parturition and interval between two successive parturitions are the most important. For a thorough analysis of the herd reproductive performance, these indices and interval need to be analysis with regard to age and seasonal factors.

1.1. Age at First Mating and First Parturition

Age at puberty is greatly affected by the system of management and probably by the type of camel. In Turkmenistan, age at puberty was reported to be as low as 8 to 12 months [4,5]. In most cases, puberty is reached at 2 years in relatively well-fed dromedaries [9,12], and at 4 to 5 years in most traditionally managed herds. Reported ages at first parturition vary between 3 and 7 years (Table 1) and depend on several factors including the breed and management system. In one study on the dromedary, this parameter was found to have very low heritability and most of the variation could be explained by management factors [21].

In a 7 year-study of a dromedary herd in the Southern Morocco, Sghiri *et al.,* 2004 [73] reported an mean age at first parturition of 3,9 ± 0,9 years with a range from 2.1 to 8 years

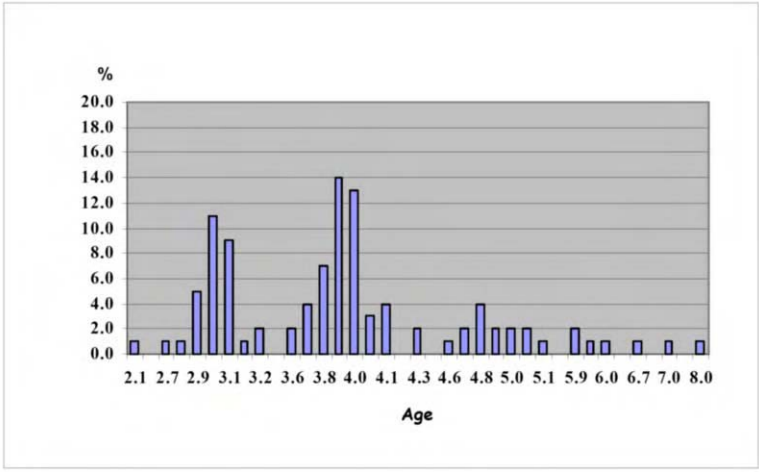

Figure 1. Percentage of females in each category of age at first parturition in a herd of dromedaries from Morocco (Mean = 3,9 ± 0,9 months).

suggesting a great opportunity for improvement through management and selection (Figure 1).

Age at first parturition is improved in herds with adequate nutrition and veterinary care [48,76]. Improvement of age at puberty and age at first parturition by nutritional and management intervention are well illustrated by Tunisian studies [41,42]. Ten out of twelve females conceived at 31.8 months at a body weight of 64% and a body size of 81% to 94% of those of the adult animal, respectively. The ration consisted of wheat straw ad libitum and a concentrate ration of 500 g/ 100 kg'/day (one UF and 19 1 g protein per/kg). In another study, all females receiving a concentrate ration and weighing more than 250 kg showed follicular activity earlier and were successfully bred at 2 years of age [55].

In well-managed herd in the UAE, we have observed an age at first conception and first parturition of respectively, 24 and 36 months [82].

1.2. Reproductive Rates

Surveys conducted on extensively managed dromedary herds suggest that the reproductive performance and particularly fertility indices are low. The annual reproductive rate and the reduplication rate vary according to years and herds from 21% to 47% and from 11.5% to 84.6%, respectively [75,76,99].

In Kenyan commercial herds with improved nutrition and preventive health program, the birth rate varies between 55% and 80%, whereas in, traditional herds this rate rarely surpasses 40% [59,67,70, 69].

In well-managed herds, fertility rate can be as high as 85% with a parturition rate of 96% [2,3]. Conception rates are 38% after one breeding and 64% after two breedings with an overall conception rate of 66.7% in primiparous females and 60% in pluriparous females [14].

In Morocco, the average annual reproductive rate and fecundity in different dromedary herds were respectively 62% and 53.3% [29,71,73].

In the United Arab Emirates the number of services per conception is 1.63 ± 0.22 with a first-service conception rate of 58% [6]. Parturition rates of 43 to 50% have been reported in Ethiopia [79,103].

In our experience, when the animals are well nourished, the most important factor in the first-service conception rate is management of breeding. Most breeders still rely on behavioral signs of heat to determine time of breeding. We have shown that these are not very accurate. In herds where the males are left with females, conception rates can be higher than in herds where hand mating is practiced. However, in herds with close veterinary monitoring, first-service conception rate can reach 72% with a birth rate of 82%.

Fertility rates vary greatly according to age groups. In Niger, where fertility rate is defined as the number of parturitions plus abortions divided by the number of females in reproduction, fertility rate is -between 31% and 48% in animals aged older than 3 years and fecundity rate is 42% [65].

In Sudan, fecundity rate in the dromedary varies between 0% and 5% for females aged 3 to 4 years, 2% to 26% for females aged 4 to 5 years, and 8% to 41% for females aged 5 to 6 years. Fecundity rate increases and plateaus between 6 and 10 years of age and depends on the type of management [64].

Conception rate of only 4.5% has been reported in Oman. The reason for this low reproductive success has not been explained by the author [58].

In Tunisia the parturition rate averages about 39% and varies according to age of the animals. Birth rate of females in age groups 2 to 3, 3 to 4, 4 to 5, and 5 to 6 years was respectively 4%, 2 l%, 37%, and 6 1%. The birth rate in females that are 7 to 13 years old ranged from 29 to 56% [32].

Management of breeding using advanced techniques such as monitoring of follicular activity by ultrasonography resulted in an ovulation rate of 88% and a pregnancy rate of 85% following a single mating (Tibary and Anouassi, personal observation).

1.3. Pregnancy Loss and Abortion

Fecundity can be influenced by the heath status of the herd, particularly with regard to trypanosomiasis and brucellosis incidence [15,16]. A clinical observation in an experimental herd showed early pregnancy loss can reach 40% during a severe outbreak of trypanosomiasis (Anouassi and Tibary, personal observation).

In nomadic herds of dromedaries, the pregnancy losses due to early embryonic death and abortions vary from 3% to 33% [65,68,100]. Stillbirth rate of 10.1% has been reported in a study in India [28]. These losses are certainly underestimated because many abortions go unnoticed.

Brucellosis (*B. abortus* or *B. meletensis*) has been reported in many countries where camels are found. The serprevalence varies from 2% to 5% in nomadic herds and form 10 to 15% in intensive herds [1]. Some authors have suggested to use vaccination for the control of this disease [1].

1.4. Interval Between Parturitions

Interval between two parturitions varies from one region to another, which suggests that management, and particularly feeding and weaning, has a great influence on this parameter (Table 2). This interval is mainly affected by the duration of lactational anestrus and the fertility of the female after the beginning of ovarian activity. In an intensively managed system the first estrus after parturition takes place at 25 days and 40 days for non-lactating and lactating females respectively [101].

The inter-parturition interval tends to decrease with increasing numbers of pregnancies. In Niger, the interval between two parturitions tends to decrease with increasing number of parturitions of the dam. In one study, this interval was 28.6, 24.0, 25.8, and 20.1 months for parturitions l-2, 2-3, 3-4, and >4 respectively [99]. In the UAE, the inter-parturition interval

Table 2. Interval between parturitions in the dromedary camels.

Country	Interval (months or days*)	Reference
India	36	(74)
India	777 ± 8* (387 to 1529)	(48,49)
Israel	380* (365 to 395)	(101)
Kenya	28.4	(68)
	24	(24)
	5.9 ± 1.4 (30 to 40)	(44)
	262± 14*	(59)
Mali	24	(77)
Morocco	24 31 8.5	(71)
Morocco	22.4 ± 7.9	(29)
Niger	25 to 38	(63)
Niger	24 to 30	
Niger	30 (24 to 38)	(65)
Northern Niger	26.2 ± 10.56	(99)
Somalia	34± 12	(16)
Sudan	28.5	(64)
Tunisia	17.5	(41) (42)
Tunisia	403.5	(54)
	714.6 1± 30.7*	
UAE	24.4	(6)

*Interval in days

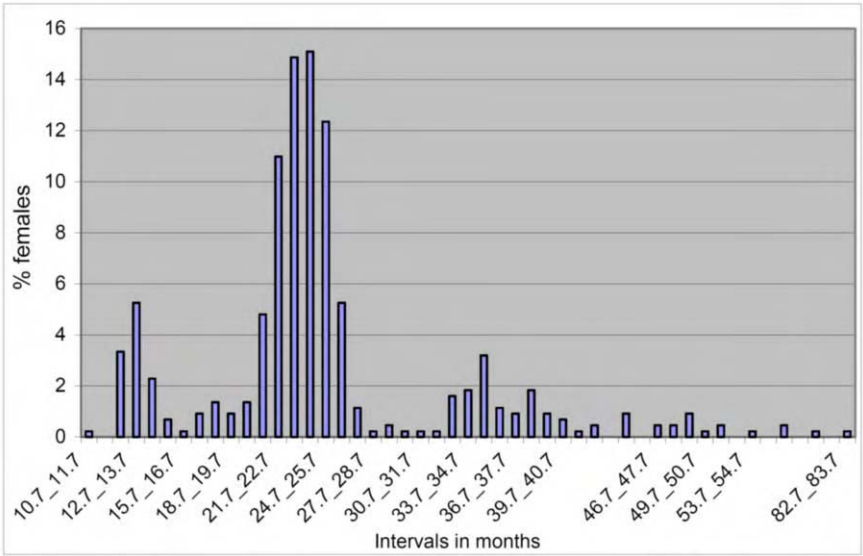

Figure 2. Percent of female in each category of interval between parturitions in a herd of dromedaries from Morocco (Mean = 25,23 ± 8,7 months).

tends to decrease from 27.5 months in animals with 1 to 3 parities to 23.1 months in animals with more than 3 parities (6). Similar findings were reported by Sghiri *et al.* in Morocco [71,73] (Figure 2). The mean interval between parturitions in a Moroccan herd was

Table 3. Reported mortality rates of young camels.

Country	Mortality rate % (age)	Reference
Ethiopia	50%	(79)
India (Bikaner)	14.9%	(28)
India (Bikaner)	11.4% (less than 6 months)	(47)
India (Bikaner)	5% (less than 6 months)	(60)
India (Thar desert)	33% (less than 6 months)	(27)
Kenya (Rendile)	27%	(45)
Kenya (Somali)	31%	(45)
Kenya (Gabra)	22%	(45)
Kenya	0 to 55%	(68)
Kenya	15%	(61)
Kenya and Sudan	10-30%	(36)
Mauritania	10%	(43)
Morocco	20.2%	(20)
Tunisia	17% (less than one year)	(32)
Saudi Arabia	13.7%(less than 6 months)	(8)
Sudan	47.9 (less than one year)	(7)

25.23 ± 8.7 months. The interval between parturition was 26,8 ± 10, 25 ± 7,3, 24,1 ± 7,3, 23,7 ± 6,6, 23,1 ± 2,7, 18,1 ± 5 for intervals between first and second, second and third, third and fourth, fourth and fifth, fifth and sixth and sixth and seven parturitions respectively [73].

The interval between parturitions can be reduced by early weaning and artificial feeding of the young. In one study, the average interval from weaning to mating was 9.1±7.8 days with a conception rate of 76.8%. The interval from parturition to mating in weaned females was 17.9±9.1 days. This technique gives an interval between parturitions of 403.5 days instead of 714.6±30.7 days [54]. The interval between parturitions can be considerably improved if nutrition is adequate and lactation length is not affected by early re-breeding [41,42,51].

Reduction of the interval between parturitions was achieved by early weaning and hormonal treatment (progesterone + eCG 2000 IU)(33,52). This treatment induces follicular activity in 58% of the females treated and results in a pregnancy rate of 40% [52].

Well-managed herds in the UAE achieve a conception rate of 85% with a parturition interval of 391±21 days. The first estrus of postpartum occurs at 29.1 (10 to 41) days [2,3]. Conception rates of 62.5% were obtained when breeding took place 70 days after parturition [14].

1.5. Neonatal Mortality

Pre-weaning mortality rate and abortion rates are probably the areas where the greatest improvement can be achieved for the increase of productivity in nomadic dromedary herds [17,26,57,67-70]. In one study, mortality rates in young varied between 7% and 15% in commercial herds or research stations and 25% to 90% in traditionally managed herds [69]. Pre-weaning losses amounted to 25.7% [100]. In Tunisia, mortality rates from 0 to 3 months and from 0 to 1 year of age were respectively 23% and 30% [32].

Diseases account for most of the losses occurring during the first 6 months of life. In a 15 year study by Kaufmann, between 60 and 82% of the deaths observed were due to a disease process [45]. Several factors can contribute to the variability of neonatal loss, these include the herd (level of care) [45,68], season as well as regional differences [78] (Table 3).

The most common encountered clinical syndromes are diarrhea and pneumonia [18,19,60]. Diarrhea is generally caused by E. coli or salmonella [18,19,22,31,53,66]. However, *coccidia* and *eimeriai* infestations have also been reported [31,102]. *Isospora* infection can cause diarrhea as early as 2 to 4 weeks of age [102]. Dehydration treatment available for field are effective [18]. Mortality rate in the first year of life in Somalia is 19.6% due mainly to meconium retention [23], camel pox infection [50], and salmonellosis [16].

Neonatal loss can increase in presence of predisposing conditions or during an outbreak of a specific disease. Wernery in the UAE has reported that copper deficiency is an important predisposing factor [95,96]. Selenium deficiency (white muscle disease) has been reported as a major cause of death (46.8%) in a herd [30]. Mortality rate due to dermatophilosis approached 30% in Sudan and Kenya [36]. Outbreaks of contagious echtyma [35], camel pox [43] and trypanosomiasis [61] with high levels of young camel mortality have been reported.

Failure of passive transfer (FPT) of immunity thorough colostrum is the primary underlying cause of neonatal infections. Neonatal care and improved management during the first week of life would likely result in a reduction of neonatal losses. Hygienic conditions for obstetrical manipulation, disinfection of the umbilicus and sufficient intake of colostrums are the most important steps. In more intensive systems, measurement of IgG in newborn camels could improve survival of those with FTP. Newborn camel should have an IgG concentration of at least 4 g/liter at 24 hours of life [13,38-40]. Methods of supplementation with colostrum from another female or use of artificial colostrum should help reduce neonatal loss due to FPT. However, implementation of these measures is often difficult in extensive herds [46].

2. Factors Affecting Reproduction at the Individual Level

2.1. Factors Affecting Female Reproductive Performance

Fertility of the herd can also be measured by the proportion of animals culled for reproductive problems. The fertility of animals is expected to decrease after a certain age. Culling age has not been defined for camelidae and depends on many factors. In milk- or meat-production dromedary herds, the culling age would be around 16 years of age, at which point the fertility of the female seems to drop. In racing dromedaries, the animals may be kept for a longer time. In Tunisian herds, the maximum number of offspring in the life of a dromedary is 7 and the end of the female reproductive life is 17 [54]. The most important aspect of culling is to determine the reason and age of animals at culling. High involuntary culling rate in breeding animals (> 5%) is usually an indication of severe management problems. In nomadic dromedary herds, culling rates for sterility range from 5% to 28% [65].

Infertility at the individual level can be due to failure of ovarian activity or ovulation or failure of fertilization or maintenance of pregnancy. Ovarian activity in the female camel is seasonal but much of this seasonality is due to nutritional status [72]. In experimental herds with good nutrition (body condition score >5) throughout the year, all females maintain ovarian activity throughout the year [86,89].

Precise diagnosis of causes of reproductive failure in the female camel is possible if advanced techniques such as ultrasonography, endometrial culture, cytology and biopsy are utilized by a trained veterinarian [80,91]. Various ovarian disorders have been diagnosed in females with reproductive problems using these techniques (Table 4) (Figures 4-6) [91]. Some of these problems, such as ovariobursitis, presents specific challenges and their etiology is not fully understood [88].

Table 4. Reproductive disorders in the female camel diagnosed clinically over an 8 year period (SM = suspicion method) and confirm (CM = confirmation method) the diagnosis (adapted from Tibary *et al.*, 2001).

Diagnosis	Number of cases	SM	CM
Disorders of the vulva and vagina			
Ambiguous gender -intersex	1	External	Cytogenetics, post-mortem
Enlarged clitoris	1	External examination	
Abnormal vulvar conformation	2	External examination	
Vaginal adhesions	4	Vaginoscopy	Videoendoscopy
Vaginitis	2	Vaginoscopy	
Double vagina	1	Vaginoscopy	Vodeendoscopy
Persistent Hymen	3	Digital palpation	Videoendoscopy
Cervicitis	2	Vaginoscopy	
Disorders of cervix			
Double cervix	2	Vaginoscopy	Videoendoscopy
Cervical adhesions	4	Manual examination	Videoendoscopy
Disorders of the uterus			
Segmental aplasia uterus	1	Ultrasonography	Laparoscopy*
Endometrial abscess	3	Ultrasonography	Videoendoscopy
Endometrial cyst	3	Ultrasonography	Videoendoscopy
Endometrial fibrosis	59	Ultrasonography	Biopsy
Endometritis	119	History, vaginoscopy	Culture, cytology, biopsy
Maceration	1	Palpation	Videoendoscopy
Mucometra	1	Palpation	Ultrasonography
Pyometra	3	Palpation	Ultrasonography
Mummification	1	Palpation	Laparotomy
Disorders of the uterine tube			
Segmental aplasia	1	All failed	Laparoscopy
Hydrosalpinx	4	Ultrasonography	Laparoscopy
Pyosalpinx	3	Ultrasonography	Laparoscopy
Salpingitis	12	All failed	Laparoscoy
Disorders of the ovary and ovarian bursa			
Ovarian hypoplasia	6	Ultrasonography	Laparoscopy
Hemorrhagic follicles and cysts	65	Palpation, ultrasonography	Ultrasonography
Ovulation failure	10	History	Endocrinology
Hydrobursitis	61	Palpation, ultrasonography	Laparotomy
Peristent luteal structures	33	Ultrasonography	Endocrinology
Ovarian adhesions	6	Palpation	Laparotomy
Ovarian tumor	1	Palpation, ultrasonography	Laparotomy
Ovario-bursal adhesions	8	Palpation, ultrasonography	laparotomy

The leading causes of infertility or early pregnancy losses in the female camel are uterine infections and uterine fibrosis (Figures 3-5) (Table 4). Several microorganisms have been associated with uterine infection [85,90]. A particular attention should be given to *campylobacter* and *trichomonas* which merit further studies to determine their role in herd infertility [94,97,98].

Figure 3. Muccopurrulent discharge in a female with uterine infection.

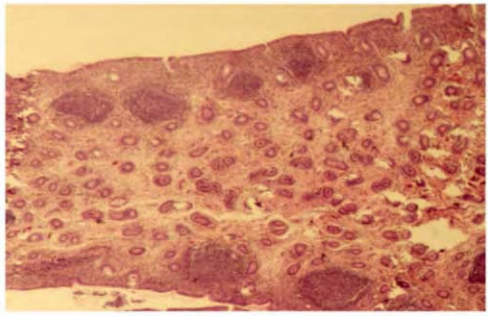

Figure 4. Endometrial biopsy from an infertile dromedary female showing chronic lymphocitic microgranulomas. The authors suspect that these lesions are relatively common in females with chronic endometritis due to trichomonosis or chlamydiosis.

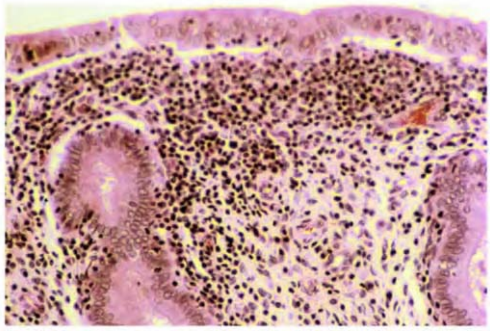

Figure 5. Endometrial biopsy from an infertile dromedary female with chronic endometritis.

Figure 6. Reproductive tracts from a female culled for infertility: Note the peri-uterine adhesions on the left horn, and the ovariobursal adhesions with accumulation of large quantity of fluid on the right ovary.

Figure 7. Traditional retainers for vaginal prolapse.

Most of uterine disorders are associated to intra-partum and postpartum complications. The most common disorders being retained placenta prolapsed uterus or vagina and dystocia (Figures 7-12). Some of these disorders may be associated to hypocalcemia or other trace-mineral deficiencies [19,92,93]. In our experience, one of the leading cause of uterine infection and loss of reproductive function is inadequate treatments or non-hygienic manipulation in the filed [83]. Veterinarians and herdsman should be educated on the proper way to handle emergencies in camel obstetrics.

2.2. Factors Affecting Male Reproductive Performance

The male impacts much of the herd fertility. The use of an infertile or subfertile male can have a catastrophic effect on reproductive performance particularly in a nomadic herd, which is not regularly observed for sexual activity or pregnancy diagnosis. Inadequate sperm production or a low male to female ratio, social interaction between males, reproductive system disease or systemic diseases, can affect fertility of the male. Documented

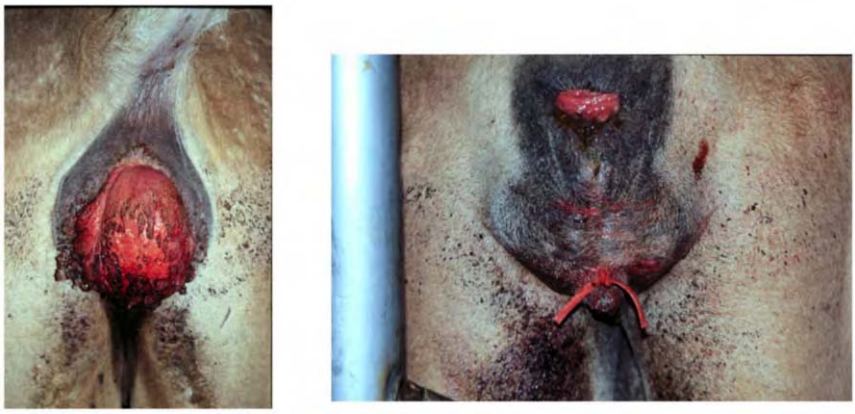

Figure 8. Vaginal prolapse before and after replacement and placement of a Buhner suture.

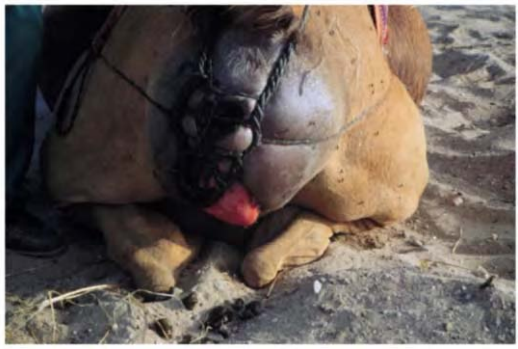

Figure 9. Traditional retainers for vaginal prolapse placed mistakenly on a female that was in the process of delivering and had a uterine torsion.

Figure 10. Retained placenta at 18 hours after delivery.

Figure 11. Uterine prolapse 4 hours after parturition.

Figure 12. Severe trauma and laceration of the vulva and the birth canal due to aggressive obstetrical manipulations.

Figure 13. Male camel presenting an orchitis.

diseases of the reproductive organs in the male camel are presented in Tables 5 and 6. Orchitis has been associated to brucellosis and larva migrans of parasites (Figure 13). Traumatic lesions of the testicles are usually associated to fighting amongst males. Poor libido is often seen in the case of severe systemic diseases (Trypanosomiasis, Hemmorrhagic diseases) or poor nutrition. Deterioration of semen quality has been observed in overused males, aged males and in males with acute trypanosomiasis [84]. Trypanosomiasis-induced infertility has been described recently in several male camels [11]. Semen characteristics from infected animals showed decreased semen motility, increased abnormalities and decreased concentration. Trypanosomiasis induced in some of the males testicular degene-

Table 5. Documented diseases of the reproductive organs in the male camelidae.

Prepuce	Penis	Testis and epididymis	Accessory sex glands
Preputial edema (heat stress) Preputial edema (trypanosomiasis) Preputial obstruction Preputial laceration Preputial prolapse Preputial necrosis Posthitis Preputial warts Phymosis	Prolapse penis Paraphymosis Balanitis Ulcerations/Abrasions Hair ring Penile warts Urethral rupture Urethritis Urolithiasis	Cryptorchidism Ectopic testicles Hydrocele Testicular degeneration Testicular hypoplasia Testicular cyst Orchitis Epididymitis Epididymal segmental aplasia	Prostate hypertrophy Prostate abscess

Table 6. Complaints and conditions diagnosed in Male camelids.

Diagnosis	Complaint	# cases	Methods
Cryptorchidism	Routine BSE	4 (3 unilat-eral)	Clinical, endocrinological
Testicular hypoplasia	Routine BSE	14	Clinical, semen evaluation
	Infertility	7	Clinical, semen evaluation, biopsy
Testicular degeneration	Infertility	32	Clinical, semen evaluation, biopsy
Testicular hematoma	Scrotal swelling	1	Ultrasound
Orchitis/epididymitis	Scrotal swelling	3	Clinical, semen evaluation, ultrasound
Testicular cysts	Infertility	3	Ultrasound, oligozoospermia,
	Sterility	1	Ultrasound, azoospermia
	Routine BSE	6	Ultrasound
Seminoma	Testicular enlargement	1	Ultrasound, histology
Prostatic enlargement (?)	Infertility, hemospermia	1	Semen evaluation, ultrasound
Preputial swelling	Preputial swelling	2 (llamas)	Clinical
Not determined	Sterility	1	
Not determined	Poor libido	1	
Not determined	Erection failure	1	

ration and altered Sertoli cell and pituitary function. The effect of trace minerals deficiencies on semen quality and testicular function is suspected but has not been fully investigated [10].

Complete breeding evaluation of the breeding male with semen collection and examination are not practical. However, physical examination and inspection and palpation of the reproductive organs, as well as observation of the first mating should be done to remove all males that display physical or behavioral abnormalities [80]. Testicular size is of paramount importance because it is well correlated with sperm production. Unfortunately, there are no guidelines for the minimum required size of the testicles for specific breeds and ages of camel [81,87].

Conclusion and Recommendations

The traditional biological limitation, proposed reasons for low reproductive performance in camels, delayed onset of puberty, long inter-parturition interval and poor survival of the young, are mainly due to lack of selection and proper management particularly nutrition

and preventive health treatment. All parameters of reproduction in camels improve with improved management in these areas.

Evaluation of reproductive performance in different production system requires a sound investigative methodology. Herds should be monitored by strategically designed visits to evaluate reproduction, health and body condition scores of all animals. This requires a well-designed standard protocol that can be used by researchers in different geographical areas and still make comparison between management systems possible. These studies are possible only all individual animals are well identified and detailed health and breeding records are kept. Identification of animals using national/regional systems should be encouraged so that animals can be tracked easily even when they change location.

With the development of production systems aiming at specific production (milk or others…) selected individual animals will become valuable and will require individual care. Knowledge of diagnosis and treatment of camel disease care has progressed tremendously in the last decade. Unfortunately, the practice of modern veterinary medicine is still lagging in the field. This is primarily due to lack of emphasis on this species in the veterinary curricula and lack of opportunities for continuing education.

Research in the field of reproduction should continue with special emphasis on effect of breeding systems (male to female ratio, length of the breeding season), the diagnosis and treatment of cause of infertility, diagnosis of the causes of abortion/pregnancy loss, the impact of some diseases processes on pregnancy, and impact of specific trace minerals on reproduction in the male and female.

Neonatal diseases and mortality still plagues camel productivity. Increased research on vaccination of the pregnant females and young stocks, supplementation for trace minerals, quick testing for failure of passive transfer and practical methods to treat diarrhea should help decrease pre and postnatal losses.

References

[1] **Abbas B., Agab H., 2002.** A review of camel brucellosis. Preventive Veterinary Medicine, 55: 47-56.

[2] **Abdel-Rahim S.E., Abdel-Rahman K., El-Nazier A.E., 1994.** Production and reproduction of one-humped camels in the Al-Qasim region, Saudi Arabia. Journal of Arid Environments, 26: 53-59.

[3] **Abdel-Rahim S.E.A., El-Nazier A.E., 1990.** Factors affecting camel reproductive performance in the tropics. Proceedings of the meeting 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 131-147.

[4] **Abdunazarov N.H., 1970.** Biological characteristics of reproduction in the one humped camel. Trudy Turkman-selkhas Inst. (Anim. Breed. Abstr., 39: 767, 1971) 15: 134-141.

[5] **Abdunazarov N.K., 1971.** Calving season and parturition in Turkmen dromedaries. Tr Turkm Skh Inst (Anim Breed Abstr, 42: 333, 1974) 16: 29-37.

[6] **Abou-Ela M.B., 1994.** Reproductive performance of the one-humped camel under traditional management in the United Arab Emirates. Journal of Arid Environments, 26: 47-51.

[7] **Agab H., 1998.** Camel pastoralism in the Butana region of Eastern Sudan: common diseases with emphasis on brucellosis. Journal of Camel Practice and Research, 5: 131-136.

[8] **Al Mutairi S.E., 2000.** Evaluation of Saudi camel calves performance under an improved management system. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 219-222.

[9] **Al-Metiery S.E., Al-Hashemy A.H., 1986.** A study on growth rate of camels in Saudi Arabia. Paper presented at MINEADEP Seminar on Camel Production and Health, Kuwait, 20-23.

[10] **Al-Qarawi A.A., Abdel-Rahman H.A., El-Belely M.S., El-Mougy S.A., 2000.** Age-related changes in plasma testosterone concentrations and genital organs content of bulk and trace elements in the male dromedary camel. Anim. Reprod. Sci., 62: 297-307.

[11] **Al-Quarawi A.A., Omar H.M., Abdel-Rahman H.A., El-Mougy S.A., El-Belely, 2004.** Trypanosomiasis-induced infertility in dromedary (*Camelus dromedarius*) bulls: changes in plasma steroids concentration and semen characteristics. Anim. Reprod. Sci., in press.

[12] **Arthur H.G., Rahim A.T., Hindi A., 1985.** Reproduction and genital diseases of the camel. Br. Vet. J., 141: 650-659.

[13] **Bada A.R., Ragounandea G., Kane Y., Sawadogo G., 2003.** Evaluation of maternal immunity transfer by colostrum in newborn dromedaries. Revue Africaine de Santé et de Productions Animales, 1: 96-100.
[14] **Bakkar M.N., Basmaeil S., 1988.** Reproductive performance in Najdi camels. Proc. 11th int. Cong. Reprod. Artif. insem., 1: 529.
[15] **Baumann M.P.O., Nuux H.A., Zessin K.H., 1990.** Herd demographic and disease survey data from herds of camels. Livestock disease survey Central Rangeland of Somalia, Technical Report, CRDP-Veterinary Component, Mogadishu, Somalia, 3.
[16] **Baumann M.P.O., Zessin K.H., 1992.** Productivity and Health of Camels (*Camelus dromedarius*) in Somalia: Associations with Trypanosomosis and Brucellosis. Trop. Anim. Hlth Prod., 24: 145-156.
[17] **Bekele T., Zeleke M., 2001.** Growth rate of the one-humped camel in semi-nomadic households in Errer Valley, eastern Ethiopia. Tropical Agriculture, 78: 206-210.
[18] **Bengoumi M., Berrada J., Farge F., Hidane K., Faye B., 2000.** Assessment of the efficacy of a specific treatment against camel calf diarrhoea. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 157-160.
[19] **Bengoumi M., Berrada J., Rochdi M., Hidane K., Lafarge F., Faye B., 1998.** Physiopathology of diarrhoea in the camel calf in Morocco. Clinical signs and metabolic disturbances. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 51: 277-281.
[20] **Bengoumi M., Gandega E.B., El Abrak A., Berrada J., Faye B., 2000.** Etude de la mortalité des chamelons au Sud du Maroc: Etude rétrospective. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 132-135.
[21] **Beniwal B.K., Chaudhry A.L., 1984.** Age at first calving in Bikaneri camel. Indian J. Anim. Sci., 54: 598-599.
[22] **Berrada J., Bengoumi M., Hidane K., 2000.** Diarrhées néonatales du chamelon dans les provinces sahariennes du Sud du Maroc: Etude bactériologique. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 153-156.
[23] **Bornstein S., 1984.** Camel health and disease. Camel forum, working paper 3, Mogadishu, Somali Academy of Science and Art
[24] **Bremaud O., 1969.** Notes sur l'élevage camelin dans les districts du nord de la République du Kenya. IEMVT, Maisons Alfort, France.
[25] **Burgemeister R., 1975.** Elevage de chameaux en Afrique du Nord. Deutsche Gesellschaft fur Zusammenarbeit GmbH, Eschborn, 86 p.
[26] **Burgemeister R., 1974.** Probleme der Dromedarhaltung und Zucht in Südtunisien. Institute für Technische Zusammenarbeit, Giessen, 99 pp.
[27] **Champak B., Sahani M., Bhakat C., 2001.** Impact of camel production system on the sustainability of marginal farmers in hot arid villages of Thar desert. Indian Journal of Animal Research, 35: 10-14.
[28] **Chowdhary B., 1986.** Some important biological and production characters of the Bikaneri camel. Indian Journal of Animal Production and Management, 2: 145-151.
[29] **Chriqi A., 1988.** Conduite de l'élevage du dromadaire dans le Sud Marocain. Thèse de Doctorat Vétérinaire, Institut Agronomique et Vétérinaire Hassan II, Rabat, Maroc.
[30] **Corbera J., Morales M., Pulido M., Montoya J., Gutierrez C., 2003.** An outbreak of nutritional muscular dystrophy in dromedary camels. Journal of Applied Animal Research, 23: 117-122.
[31] **Dia M., Diop A., Ahmed O., Diop C., El H.O., 2000.** Camel calf diarrhoea in Mauritania: survey results. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 149-152.
[32] **Djellouli M.S., Saint-Martin G., 1992.** Productivity and economy of camel breeding in Tunisia. Proc 1st int. Camel Conf., Dubai, UAE, 209-212.
[33] **Elias E., 1990.** Early Weaning and Postpartum Conception in the One-Humped Camel (*Camelus dromedarius*) - Review. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 239-255.
[34] **Field C.R., Simpkin S.P., 1985.** The importance of camels to subsistence pastoralists in Kenya. Nairobi, UNESCO, IPAL Tech. Report No E-7, 161-192.
[35] **Gitao C., 1994.** Outbreaks of contagious ecthyma in camels (*Camelus dromedarius*) in the Turkana district of Kenya. Revue Scientifique et Technique Office International des Epizooties, 13: 939-945.
[36] **Gitao C., Agab H., Khalifalla A., Jongejan F., Goff W., Camus E., 1998.** A comparison of camel dermatophilosis in Kenya and Sudan. Annals of the New-York Academy of Sciences, 849: 461-464.
[37] **Hira I.M., 1947.** Camel breeding in India. Indian Fmg, 8: 504.
[38] **Hulsebusch C., 2000.** Immunoglobulin-G status of camels during six months post-natum. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 105-110.
[39] **Kamber R., Farah Z., Rusch P., Hassig M., 2000.** Studies on the supply of immunoglobulin G to newborn camel calves (*Camelus dromedarius*). SAT, Schweizer Archiv fur Tierheilkunde, 42: 581-588.
[40] **Kamber R., Farah Z., Rusch P., Hassig M., 2001.** Studies on the supply of immunoglobulin G to newborn camel calves (*Camelus dromedarius*). Journal of Dairy Research, 68: 1-7.

[41] **Kamoun M., 1990.** Reproduction and production of Maghrabi dromedaries raised on a Mediterranean type pasture. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 117-130.
[42] **Kamoun M., Wilson R.T., 1994.** Improving early reproductive characteristics of Tunisian camels by nutritional and management interventions. Journal of Arid Environment, 89-94.
[43] **Kane Y., Diallo B., 2000.** Data on camel calf diseases in Mauritania. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 161-163.
[44] **Karimi S.K., Kimenye D.M., 1990.** Some observations on the reproductive performance of camels kept in Marsabit, Northern Kenya. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 353-365.
[45] **Kaufmann B., 2000.** Camel calf losses and calf care measures in pastoral herds of Northern Kenya. A system view. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 137-144.
[46] **Kaufmann B., 2003.** Differences in perception of causes of camel calf losses between pastoralists and scientists. Experimental Agriculture, 39: 363-378.
[47] **Khanna N., Tandon S., Sahani M., Allen W., Higgins A., Mayhew I., Snow D., Wade J., 1992.** Calf mortality in Indian camels. Proceedings of the First International Camel Conference, Dubai, 2nd 6th February 1992.
[48] **Khanna N.D., Tandon S.N., Rai A.K., 1990.** Breeding parameters of Indian camels. Indian Journal of Animal Science, 60: 1347-1354.
[49] **Khanna N.D., Tandon S.N., Rai A.K., 1990.** Reproductive Status of Bikaneri Camels Managed Under Farm Conditions. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 337-352.
[50] **Kritz B., 1982.** A study on camelpox in Somalia. J. Comp. Path., 92: 1-8.
[51] **Lahlou Kassi A., Anouassi A., Sghiri A., 1989.** Nutrition et reproduction chez le dromadaire. Options méditerranéennes, Série Séminaire No. 2: 141-149.
[52] **Minoia P., Moslah M., Lacalandra G.M., Khorchani T., Zarrilli A., 1992.** Induction of oestrus and management of reproduction in the female dromedary camel. Proc 1st int. camel conf., Dubai UAE, 119-123.
[53] **Mohammed M., Hart C., Kadden O., 2003.** Viruses and bacteria associated with neonatal camel calf diarrhoea in Eastern Sudan. Emirates Journal of Agricultural Sciences, 15: 56-62.
[54] **Moslah M., 1990.** Early separation and artificial suckling of the new-born to improve the breeding performance of the dromedaries in Tunisia. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 225-238.
[55] **Moslah M., 1990.** L'amélioration de la productivité du dromadaire en Tunisie. Proc. of the workshop, 'Is it possible to improve the reproductive performance in the camel?' Paris.
[56] **Moslah M., Megdiche F., 1989.** L'élevage du dromadaire en Tunisie. Options méditerranéennes, Série séminaires, No. 2: 33-36.
[57] **Musa B., Merkt H., Wardeh M., Wilson R., Zaied A., 1991.** Reproductive performance in the female camel (*Camelus dromedarius*). Proceedings of the International Conference on Camel Production and Improvement, 10-13 December, 1990, Tobruk, Libya, 87-92.
[58] **Musa B., Salim M., Samra M., 2000.** Omani camel calves in a traditional management system. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 209-212.
[59] **Mutugi M.W., Olaho-Mukani W., Kuto B., Alushula H., A.R. N., 1992.** Some reproductive parameters in a Kenyan population of *Camelus dromedarius*. Bull. Anim. Hlth Prod. Afr., 40: 215-217.
[60] **Nagpal G., Purohit G., 2001.** Field prevalence of disease and calf mortality in camel rearing areas in Bikaner. Indian Veterinary Journal, 78: 787-789.
[61] **Njiru Z., Ole M.I., Ouma J., Ndung U.J., Olaho M.W., 2000.** Prevalence of trypanosomosis in camel calves: a pilot study in Laikipia District of Kenya. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 183-186.
[62] **Planchenault D., 1984.** Projet de développement de l'élevage dans le Niger Centre Est. Production cameline. Résultats zootechniques, IEMVT, Maisons-Alfort, 213 pp., 163-175.
[63] **Richard D., Planchenault D., Giovanneti J.F., 1985.** Projet de développement de l'élevage dans le Niger Centre-Est. Production Cameline Rapport Final Maisons-Alfort, IEMVT, 125 pp.
[64] **Saint-Martin G., Maillard A., Roy F., Musa B.E., 1990.** Reproductive performance of camels in real-life situation. Example of an inquiry in Butana, Sudan. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 387-407.
[65] **Saley M., 1990.** Reproductive performance of the dromedary in Niger (*Camelus dromedarius*). Prospects for improvement. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 379-386.
[66] **Salih O., Shigidi M., Mohammed H., McDoungh P., Chang Y., 1997.** Bacteria isolated from camel-calves (*Camelus dromedarius*) with diarrhea. Camel Newsletter, 13: 34-43.

[67] **Schwartz H.J., 1989.** Productivity and utilisation of the one-humped camel (*Camelus dromedarius*) in Africa. Consultant Report to FAO, Rome and Berlin.
[68] **Schwartz H.J., Dolan R., Wilson A.J., 1983.** Camel production in Kenya and its constraints. I. Productivity. Trop. Anim. Health Prod., 15: 169-179.
[69] **Schwartz H.J., Walsh M.G.H., 1990.** Improving Reproductive Performance in the Dromedary: Consequences to Production Systems. Proceedings of the workshop 'Is it Possible to Improve the Reproductive Performance of the Camel?' - Paris, 409-425.
[70] **Schwartz H.J., Wilson A.J., Dolan R., Evans J.O., Fairhall J., 1982.** Produktionsleistungen von Kamelen. Prakt Tierarzt, 63: 964-969.
[71] **Sghiri A., 1988.** Evaluation des performances de reproduction d'un troupeau camelin à Laayoune *(Camelus dromedarius)*. Thèse de Doctorat Vétérinaire, Institut Agronomique et Vétérinaire Hassan II, Rabat, Maroc
[72] **Sghiri A., Driancourt M.A., 1999.** Seasonal effects on fertility and ovarian follicular growth and maturation in camels (*Camelus dromedarius*). Anim. Reprod. Sci., 55: 223-237.
[73] **Sghiri A., Tibary A., Anouassi A., 2004.** Evaluation des performances de reproduction dans un élevage de dromadaire (*Camelus dromedarius*). Proc. Congrès Maghrébin de Médecine Vétérinaire, Alger, Algérie, May 4-5.
[74] **Sharma V.D., Bhargava K.K., Singh M., 1963.** Secondary sex ratio of normal births in Bikaneri camels. Indian Vet. J., 40: 561-563.
[75] **Simpkin S.P., 1985.** The effects of disease as constraints to camel production in northern Kenya. *In:* Camel diseases and Productivity in the Arid Lands of Northern Kenya IPAL Technical report No E-7 United Nations Educational, Social and Cultural Organisation, Nairobi, 77-160.
[76] **Simpkin S.P., 1987.** A summary of the increased productivity in camels as a result of application of a vet. management. Proc Workshop Camel Mgmt Ecol, Landskrona, Swenda Landskrona, Terra Nov. 1987.
[77] **Swift J.J., 1979.** The economics of traditional nomadic pastoralism: The Twareg of the Adrar in Iforas (Mali). PhD Thesis, Sussex University
[78] **Tandon S., Bissa U., Khanna N., 1988.** Mortality rates in Bikaneri camels maintained at an organized farm. Indian Journal of Animal Sciences, 58: 132-137.
[79] **Tefera M., Gebreah F., 2001.** A study on the productivity and diseases of camels in Eastern Ethiopia. Tropical Animal Health and Production, 33: 265-274.
[80] **Tibary A., Anouassi A., 1997.** Breeding Soundness Examination of the Female Camelidae. *In:* Tibary A. (ed), Theriogenology in Camelidae: Anatomy, Physiology, BSE, Pathology and artificial breeding: Actes Editions, Institut Agronomique et Vétérinaire Hassan II, 243-310.
[81] **Tibary A., Anouassi A., 1997.** Male Breeding Soundness Examination. *In:* Tibary A. (ed), Theriogenology in Camelidae: Anatomy, Physiology, BSE, Pathology and artificial breeding: Actes Editions, Institut Agronomique et Vétérinaire Hassan II, 79-111.
[82] **Tibary A., Anouassi A., 1997.** Management of Reproduction in Camelidae. *In:* Tibary A. (ed), Theriogenology in Camelidae: Anatomy, Physiology, BSE, Pathology and artificial breeding: Actes Editions, Institut Agronomique et Vétérinaire Hassan II, 459-476.
[83] **Tibary A., Anouassi A., 2001.** Obstetrics in Camels. *In:* Recent Advances in Camelid Reproduction, Skidmore L. and Adams G.P. (Eds.) Ithaca: International Veterinary Information Service, A1005.0501.
[84] **Tibary A., Anouassi A., 1997.** Pathology and Surgery of the Reproductive Tract and Associated Organs in the Male Camelidae. *In:* Tibary A. (ed), Theriogenology in Camelidae: Anatomy, Physiology, BSE, Pathology and artificial breeding: Actes Editions, Institut Agronomique et Vétérinaire Hassan II, 115-132.
[85] **Tibary A., Anouassi A., 2000.** Reproductive Disorders in the Female Camelid. *In:* Recent Advances in Camelid Reproduction, Skidmore L. and Adams G.P. (Eds.) Ithaca: International Veterinary Information Service, A1007.1100.
[86] **Tibary A., Anouassi A., 1997.** Reproductive Physiology in the Female Camelidae. *In:* Tibary A. (ed.), Theriogenology in Camelidae: Anatomy, Physiology, BSE, Pathology and artificial breeding: Actes Editions, Institut Agronomique et Vétérinaire Hassan II, 317-368.
[87] **Tibary A., Anouassi A., 1997.** Reproductive Physiology of the Male. *In:* Tibary A. (ed.), Theriogenology in Camelidae: Anatomy, Physiology, BSE, Pathology and artificial breeding: Actes Editions, Institut Agronomique et Vétérinaire Hassan II, 49-74.
[88] **Tibary A., Anouassi A., 2001.** Retrospective study on an unusual form of ovario-bursal pathology in the camel (*Camelus dromedarius*). Theriogenology, 56: 415-424.
[89] **Tibary A., Anouassi A., 1996.** Ultrasonographic Changes of the Reproductive-Tract in the Female Camel (*Camelus dromedarius*) during the Follicular Cycle and Pregnancy. Journal of Camel Practice and Research, 3: 71-90.
[90] **Tibary A., Anouassi A., 2001.** Uterine infections in camelidae. Veterinary Science Tomorrow, 1.

[91] **Tibary A., Anouassi A., Memon M.A., 2001.** Approach to infertility diagnosis in camelids: retrospective study in alpacas, llamas and camels. Journal of Camel Practice and Research, 8: 167-179.
[92] **Van Straten M., 1998.** Hypocalcaemia in two female camels (*Camelus dromedarius*): a case report. Journal of Camel Practice and Research, 5: 287.
[93] **Van Straten M., 1997.** Uterine prolapse in the dromedary camel. Journal of Camel Practice and Research, 4: 29-29.
[94] **Wernery U., 1991.** The barren camel with endometritis - isolation of Trichomonas fetus and different bacteria. Journal of Veterinary Medicine Series B, 38: 523-528.
[95] **Wernery U., Ali M., Kinne J., Abraham A., Wernery R.., 2002.** Copper deficiency: a predisposing factor to septicaemia in dromedary calves. Journal of Camel Practice and Research, 9: 59-66.
[96] **Wernery U., Kinne J., Abraham A., 2002.** Treatment of copper deficiency in two dromedary calves. Journal of Camel Practice and Research, 9: 83-84.
[97] **Wernery U., Kumar B., 1994.** Reproductive disorders in dromedary camels due to infectious causes and its treatment. Journal of Camel Practice and Research, 1: 85-87.
[98] **Wernery U., Wernery R., Allen W., Higgins A., Mayhew I., Snow D., Wade J., 1992.** Uterine infections in the dromedary camel - a review. Proceedings of the First International Camel Conference, Dubai, 2nd 6th February 1992, 155-158.
[99] **Wilson R.T., 1984.** Quelques paramètres de la reproduction chez la chamelle de l'Aïr (République du Niger). Reproduction des ruminants en zone tropicale, Colloque INRA 20: 147-155.
[100] **Wilson R.T., 1986.** Reproductive Performance and Survival of Young One-Humped Camels on Kenya Commercial Ranches. Anim. Prod., 42: 375-380.
[101] **Yagil R., Etzion Z., 1984.** Enhanced Reproduction in Camels (*Camelus dromedarius*). Comp. Biochem. Physiol., 79A: 201-204.
[102] **Younan M., McDonough S., Herbert D., Saez J., Kibor A., 2002.** Isospora excretion in scouring camel calves (*Camelus dromedarius*). Veterinary Record, 151: 548-549.
[103] **Zeleke M., Bekele T., 2000.** Camel herd health and productivity in eastern Ethiopia selected seminomadic households. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 53: 213-217.

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Assisted Reproduction in Dromedary Camels

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Abstract. Ejaculates were collected from male camels using an artificial vagina and diluted 1:1 (v:v) in Green buffer, before a total of $300x10^6$ live sperm was inseminated into each female camel 24h after injection (i.v.) with 20µg of the GnRH analogue, Buserelin, to make them ovulate. Further ejaculates were collected, diluted in Green Buffer as before, and stored in an Equitainer (Hamilton Thorn, Canvers, MA, USA) at 4°C for 24h before insemination. While pregnancy rates of 50 - 60% were achieved with camels inseminated with fresh diluted semen, the conception rate decreased to 25% in camels inseminated with semen cooled for 24h.

For embryo transfer, donor camels were treated with a combination of 2500 iu equine Chorionic Gonadotrophin (eCG) and 400 mg porcine Follicle Stimulating Hormone (pFSH). When the follicles had matured to between 1.3 - 1.8 cm in diameter the camel was mated, and the uterus flushed, non–surgically, 8 days later. The recovered embryos were either i) directly transferred, non-surgically, into recipient camels at day 6 after ovulation, ii) cooled in embryo flushing media for 24h in an Equitainer at 4°C before transfer or, iii) deep-frozen using 1.5M ethanediol as the cryoprotectant and using slow, controlled-rate cooling methods before thawing, rehydrating and transferring into recipient camels. A pregnancy rate of 67% was obtained after transfer of fresh embryos into day 6 recipients which was similar to that obtained after transfer of embryos cooled for 24h at 4°C (63%). However the pregnancy rate was much reduced to 32% after transfer of frozen/thawed embryos into recipient animals.

These results show that using assisted reproduction techniques it is possible increase the number of offspring from desirable genetic combinations.

Introduction

Reproductive efficiency of camels is low because of their late age of reaching puberty, short breeding season, long gestation period and relatively long period of lactational anoestrus [10]. However, assisted reproductive techniques such as artificial insemination (A.I.) and embryo transfer (E.T.) can be used to overcome these problems and greatly increase the productivity of the male and female animals and thereby increase the overall rate of progress in genetic improvement [11].

In many mammalian species the development of reliable methods for the cryopreservation of embryos and semen has been well established and this has enabled a more widespread application of A.I. and embryo transfer for genetic management and improvement without the need for transporting live animals [4]. In addition cryopreservation removes the time constraints for planning embryo transfer programmes as recipients do not have to be

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artificially synchronized with, or even be in the same location as, the donor as the embryos can be stored, then thawed and transferred to recipients during natural ovarian cycles. Also cryopreservation of embryos and semen can prolong the reproductive life of the male and female camels as they can be stored, then transferred even after the death of the donor animal. Another important advantage of using assisted reproductive techniques, is that it can greatly reduce the risk of transmitting certain diseases [8].

In the dromedary camel methods for the collection and transfer of fresh embryos [5,7] and semen [2] have been documented but more research is needed to improve results after transfer of frozen/thawed embryos and insemination of cooled semen. This study discusses the results after AI and embryo transfer of fresh, cooled and frozen embryos.

1. Material and Methods

1.1. Artificial Insemination

The ovaries of the female camels to be inseminated were examined regularly by transrectal ultrasonography using an Aloka Model 500 realtime scanner with a 5 MHz linear array transducer (Al Carmal, Dubai, UAE) and when there was a follicle in their ovaries of between 1.3 – 1.8 cm in diameter they were injected intravenously with 20μg of the GnRH analogue Buserelin, (Receptal, Hoechst Animal Health, Milton Keynes, UK) to induce ovulation [6].

Semen was collected from male camels using a modified bull artificial vagina, of 30cm in length and 5cm internal diameter, with a water-jacketed collection vessel attached [2]. After collection the ejaculate was diluted 1:1 (v:v) in Green Buffer for camel semen (I.M.V. L'Aigle, France) containing 10% (v:v) added egg yolk, and the motility and concentration were evaluated. A total of 300 x 10^6 live spermatozoa were then inseminated into the uterus of each female, 24h after the injection of GnRH, using a bovine insemination catheter passed through the cervix [2].

Further ejaculates were collected, diluted in Green buffer as described above and stored in an Equitainer (Hamilton-Thorn, Canvers, MA, USA) where the cans used to cool the equitainer are placed in a freezer for at least 24h before use. The semen was sealed in a plastic universal, which was wrapped in two thermal ballast bags at room temperature and placed within a plastic cup inside the equitainer before closing the lid. The semen was inseminated 24h later, as described above, providing it contained at least 30-35% motile spermatozoa.

1.2. Embryo Transfer

1.2.1. Treatment of Donor Camels

The ovaries of the donor camels (n=35) were scanned regularly and when follicular development in their ovaries was at a minimum each donor camel was treated with a combination of 2500 IU eCG (Folligon; Intervet Laboratories, Cambridge, UK.) administered as a single intramuscular injection on Day 1 of the treatment protocol and a total dose of 400 mg pFSH (Folltropin; Vetrepharm, Ireland) injected twice daily, intramuscularly, in declining doses of 80, 60, 40, and 20 mg on Days 1 – 4. When the majority of the follicles had grown to between 1.3 – 1.8cm in diameter the female was mated twice, 24h apart, to one of three mature male camels.

1.2.2. Treatment of Recipient Camels

The ovaries of the recipient camels were examined as described for the donor animals and when a follicle of 1.3 – 1.8cm was present in their ovaries they were injected with 20μg

GnRH to induce ovulation which was subsequently confirmed by ultrasound 24 – 48 h after injection. The embryos were then transferred on day 6 after ovulation (Day 0 = the day after mating, as camels (being induced ovulators) only ovulate 24 – 36h after mating has occurred) and pregnancy diagnosed by ultrasonography of the uterus between 18 – 20 days after ovulation [9].

1.2.3. Embryo Recovery and Transfer

The uteri of the donors were flushed non-surgically 7 days after ovulation by transcervical uterine lavage as described by Skidmore *et al.,* [7] and the recovered medium filtered through a sterile embryo filter (Emcon Filter; Immuno Systems Inc., Wisconsin, USA) before the residual filtrate was searched for embryos. The embryos subsequently selected for transfer were aspirated into 0.25ml straws, loaded into an embryo transfer pipette (I.M.V.) before being transferred non-surgically by guiding the pipette through the cervix and into the left horn of the uterus as described by Skidmore *et al.,* [7].

1.2.4. Treatment of Embryos

All embryos were washed three times in fresh flushing medium and then treated in one of three ways.

a) Controls – underwent no further treatment, the embryos were directly transferred into day 6 recipient camels.
b) Transferred into small bijou bottles filled with 5ml of fresh flushing media containing 10% v/v fetal calf serum (FCS, Sigma Chemical Co. Poole, Dorset, UK) which were then sealed and placed in an Equitainer. The Equitainer was opened 24h later, the embryos recovered from the bijou bottles and washed in fresh flushing medium before their morphology assessed. Those of Grade 2 or greater were transferred.
c) Exposed to 1.5M ethanediol in holding medium (HM = Hepes-buffered Tyrodes medium containing sodium lactate and 3mg-ml^{-1} bovine serum albumin (Biowhittaker, Walkersville, MD, U.S.A.), 10% fetal calf serum, (Hyclone, Logan, UT, USA), and 100u-ml^{-1} penicillin G, 100 µg-ml^{-1} streptomycin and 25 µg-ml^{-1} amphotercin B (Gibco, Grand Island, NY, USA) for 10 min before loading individually into a 0.25ml straws, which were sealed and placed in an embryo freezing machine (Nicool Bag, MS 21; I.M.V, France) at –7°C. The straws were seeded after 1 min and held for a further 10 min to equilibrate before the temperature was lowered at 0.5°C/min to –33°C when the straws were plunged into liquid nitrogen. The straws were later thawed by holding in air for 6 secs, then swirling in a water bath at 32°C for 2 min before being rehydrated in one of 3 ways i) expelled directly into HM, ii) expelled into 0.2M sucrose in HM and incubated at room temperature (RT) for 10 min or iii) for 5 mins, before being transferred to fresh HM. Those embryos of Grade 3 or greater after 1-2h culture in HM at 37°C were transferred to recipient camels.

2. Results

2.1. Artificial Insemination

The average volume of semen collected was 4ml (range 3–8 ml) with a concentration of between 300 – 400 x10^6 spermatozoa ml^{-1}. The motility was rather more difficult to assess due to the gelatinous nature of the secondary sex gland secretions mixed with the spermato-

Table 1. Viability of cryopreserved camel embryos after controlled rate freezing.

Cry preservation method: exposure to 1.5M ethandiol	Method of rehydration	No of embryos	No. of embryos transferred	No of pregnancies.
10 min	HM	28	12	4 (33)
10 min	SM (10) – HM	18	12	3 (25)
10 min	SM (5) – HM	21	19	7 (37)

HM: Holding medium
SM: 0.2M sucrose in HM for 10 min (10) or 5 min (5) at room temperature.

zoa but after dilution with Green buffer and a period of 20 min at room temperature the semen had liquefied enough to enable an estimate of motility to be recorded. Motility ranged between 65 – 75% in fresh semen samples and 25 - 30% after 24h at 4°C. Pregnancy was diagnosed in 8/14 (57%) of camels inseminated with fresh semen and 3/12 (25%) of camels inseminated with cooled semen.

2.2. Embryo Transfer

Thirty-two of the 35 donors treated with eCG and pFSH responded by growing more than 4 follicles that matured to between 1.3 – 1.8cm in diameter within 8 – 12 days from the start of treatment. These donors were then mated and a total of 127 embryos recovered from 30 of the 32 animals that were flushed.

2.2.1. Transfer of Fresh and Cooled Embryos

A total of 28 embryos were transferred to day 6 recipients immediately after collection which resulted in 19 (67%) pregnancies. A further 34 embryos were cooled in the Equitainer and 24h later 32 of them were of Grade 2 or better and therefore transferred to recipient animals which resulted in 20 pregnancies (63%). This was a success rate similar to that achieved when transferring fresh embryos.

2.2.2. Transfer of Frozen-Thawed Embryos

As shown in Table 1 the survival rate (after 2h in culture) of the embryos rehydrated in 0.2M sucrose for 5 min before being transferred to HM was 19/21 (90%) which was greater than those rehydrated in 0.2M sucrose for 10 min 12/18 (66%) or those directly rehydrated in HM 12/28 (43%). Forty-three of the embryos that survived after 2h in culture were transferred and resulted in 14 pregnancies (see Table 1).

3. Discussion

These results show that it is possible to collect, dilute and inseminate fresh semen 24h after induction of ovulation and achieve acceptable conception rates. Ovulation in this study was successfully achieved using a single (iv) injection of GnRH whereas previous studies used mating to a vasectomized male to induce ovulation [1]. This is not such a practical method as a vasectomised male cannot mate that many females at one time and it also increases the risk of transmitting venereal diseases. The conception rate following insemination with

cooled semen was however dramatically reduced. This maybe due to the gelatinous nature of the semen making it difficult to mix the semen and the extender well enough for the extender to provide adequate protection to the spermatozoa, or perhaps different diluents are required to extend camel semen prior to cooling and this needs further investigation.

Earlier studies have shown that it is possible to produce live offspring by embryo transfer and these results show that there does not seem to be any reduction in viability of the embryo due to storage at 4°C in an Equitainer, as pregnancy rates of 63% were achieved when cooled embryos were transferred verses 67% when fresh embryos were transferred into day 6 recipients. However, pregnancy rates were much reduced when frozen/thawed embryos were transferred.

Previous studies have shown that equilibration in 1.5M ethanediol for 10 min is preferable to equilibration for only 1 or 5 mins indicating that perhaps these shorter time intervals were insufficient for the cryoprotectant to penetrate and protect the inner cell mass (Skidmore *et al,* submitted). Also embryos rehydrated in 0.2M sucrose in HM for just 5 mins showed improved survival rates when compared with those expelled directly into HM or into 0.2M sucrose in HM for 10 mins. This suggests that perhaps using sucrose in the medium causes a more gradual rehydration thereby preventing excessive osmotic shock which is beneficial to the thawed embryos. However, prolonged exposure could be detrimental because it may interfere with the proper rehydration of the cells or blastocoel. A higher proportion of hatched porcine blastocysts were also found to survive cryopreservation better if they were rehydrated in medium containing sucrose when compared to those rehydrated without sucrose [3].

From these experiments we can conclude that it is possible to use assisted reproduction techniques such as AI and ET of fresh semen and embryos to improve the reproductive efficiency of camels. In addition offspring can be obtained after insemination of cooled semen and cooled or frozen/thawed embryos although further research is necessary to improve these pregnancy rates.

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References

[1] **Anouassi, A., Adnani, M. and El Raed** (1992). Artificial insemination in the camel requires induction of ovulation to achieve pregnancy. *Proc. 1st Int. Camel Conf.* pp. 175-178. Eds. W.R. Allen, A.J. Higgins, I.G. Mayhew, D.H. Snow and J.F. Wade. R & W Publications (Newmarket) Ltd. UK.

[2] **Bravo, P.W., Skidmore, J.A., and Zhao, X.X**. (2000). Reproductive aspects and storage of semen in Camelidae. *In:* Storage of Semen of Domestic Animals. S. Salamon and W.M.C. Maxwell (Eds). *Animal Reproduction Science*, 62, 173-193.

[3] **Kobayashi, S., Takei, M., Kano, M., Tomita, M. and Leibo, S.M. (1998).** Piglets produced by transfer of vitrified porcine embryos after stepwise dilution of cryoprotectants. *Cryobiology* 33, 459 – 464.

[4] **Leibo, S.P.** (1986). Cryobiology: Preservation of mammalian embryos. *In:* Genetic Engineering of Animals. Eds. J.W. Evans and A. Hollaender. Plenum Press, New York, pp. 251 – 272.

[5] **McKinnon, A.O., Tinson, A.H. and Nation, G.** (1994). Embryo transfer in dromedary camels. *Theriogenology,* 41, 145-150.

[6] **Skidmore, J.A., Billah, M. and Allen, W.R**. (1996). The ovarian follicular wave pattern and induction of ovulation in the mated and non-mated one-humped camel (*Camelus dromedarius*). *J. Reprod. Fert*. 106, 185 – 192.

[7] **Skidmore, J. A., Billah, M. and Allen, W.R.** (2002). Investigation of factors affecting pregnancy rate after embryo transfer in dromedary camels. Reproduction, Fertility and Development, 14, 109 – 116.

[8] **Stringfellow, D.A. and Seidel, S.** 1998. Manual of the International Embryo Transfer Society (3rd Edition), International Embryo Transfer Society Savoy, Illinois.
[9] **Tinson, A.H. and McKinnon, A.O.** (1992). Ultrasonography of the reproductive tract of the female dromedary camel. *Proc. 1st Int. Camel Conf.* pp. 129-137. Eds. WR Allen, AJ Higgins, IG Mayhew, DH Snow, JF Wade. R&W Publications (Newmarket) Ltd. UK.
[10] **Wilson, R.T.** (1984). *The Camel.* pp. 83-102. Longman, London, New York.
[11] **Yagil, R. and von Creveld, C.** (1990). Embryo transfer technology in camels (*Camelus dromedarius)*. Why and How. *In:* 'Is it possible to improve the reproductive performance of the camel?' *Proc. UCEC Workshop*, Paris.

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Camel Genetic Resources and Ways of Camel Breeding Products Use for Population of Kazakstan Arid Areas

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Abstract. The camel population decreased dramatically in Kazakhstan. However a selection programme was set up for milk and meat production improvement. The perspectives are described.

Introduction

Market economy of Kazakhstan is installed the problem for review of livestock breeding policy in agriculture including camel breeding. The development of this problem should be arranged on base of new technology involvement. Within hard competitive the revenue of agriculture would be supplied only for account technological progress.

At present time the camel breeding in Kazakhstan is traditional branch of husbandry. In Kazakhstan arid areas the camels are grazing whole year on rangelands and would be able to supply the population with high quality and ecological products as milk, meat, leather and at the same time transportation vehicle.

1. Camel Population and Production in Kazakhstan

At present time in state there are over 100 000 heads of camel including Bactrian Kazakh is 85 000, other are hybrids of several generations and couple of Turkmen dromedary. Annually they are produced 25-30 000 tons of milk, 210 000 tons of wool and 2.5-3 000 tons of meat. The main problem is storage, processing and supply of products, especially milk products.

In desert and semi desert areas on 120 millions ha is possible to increase the camel heads up to 2 millions and *shubat* production up to 350-380 000 tons per year. However, the richest possibility of country to enlarge the milk and meat sources under camel breeding does not use significantly.

For increasing production including milk is needed intensification that is required the improvement of management basing on adoption of intensive technology. Intensive technology would be increased productivity of animals and its genetic values including such features as modest to fodder and climatic conditions of desert areas.

Currently, the farmers are needed the milk high quality camel varieties that would be compare with cows. Thus competitive ability is significant factor for increasing the number of heads and in establishment of new camel varieties. For shubat production the farmers are

imported the Turkmen dromedary. However, the efforts for their introduction in Kazakh Bactrian breeding areas were not successful even in south areas due to winter cold condition.

2. Camel Selection and Improvement Programme

In that case and basing on multi years researches are developed the selection method on patent level for improvement of camel milk productivity. This method would be increased the camel milk production with fat of 4,5% to 4 and more times in compare with milk productivity of pure Bactrian (RK Patent Nr. №24436). Given work is provided in Karalpak farm, Sozak Raion, South-Kazakhstan Oblast. In this farm the average day yield of one camel is 10 liters for lactation period and year yield is 27 tones. Such quantity of milk production is achieved at whole year grazing on rangelands. At introduction of new technology (RK Patent Nr.6237) for shubat production with long term of storage, the profit would be approximately 20 thousand USD per year. This data is approved the perspective of camel milk production in Kazakhstan arid areas.

Also for intensification of this husbandry branch were provided some works for mechanization of technological processes and project works for development of technical devices that included to technological processes for farm conditions.

This new technology included the camel milk processing, camel skin processing and new technical devices for to milk and to shear of camels that confirmed by 4 patents (USSR) and 12 patents RK.

The developed technology is foreseen the step-by-step completion of technical processes with application of new technical devices, beginning from selection and train of camels to milk and transportation of products to customer.

At present time for sanitarium camel application is used unusual materials that taken from equipment for horses, LRA, SRA. These elements are not suitable for work with camels. Therefore such procedures are provided poor.

These measures are feasible by many reasons such as huge size of camel where height is over 2 meters with weight up to 1000 kg. And so actual work is shown that is needed special development of equipment for applying in real basis.

We developed equipment for sanitarium camel application that quite easy to use in difficulty places of animal body. This is comb that designed under biological properties of animal and his wool mass grows. Using this comb for one pass is provided the full processing of wool and access for medicine injection.

Other problem is mechanization of camel assessment including weighting and body measurement.

Currently is used the weight on ground that have large parameters and mass up to 300 kg. It has many problems in transportation, assembling. So farmers have not possibilities to assess the animal and they visually indicated the body mass.

We developed new weight with easy assembling that may be used to weight the camel with accuracy.

Also important role is precise assessment of camel body. For class identification in breeding work is needed such parameters as: height, length, breast length, heel embracement, and for milk equipment are needed: dimension of udder, nipple and nipple location relatively to udder.

We developed the design of some devices for precise body assessment and for measurement of nipples and for one step is possible to measure the angle deviation of nipple from vertical and diameter of nipple base and tip and length.

For easy work of udder massage we produced the experimental rig for udder massage that have been tested and recommended for serial producing.

The udder and nipple massage are allowed to form the conditional reflex of females to milk. In result we received additionally the 360 kg of milk more in average in compare to same females without massage.

So the camel is natural node in livestock for arid area development and in regulation of biosystem and ecosystem in sands, saline territories of republic.

Rational use of fodder resources in desert pastures and labor management under market economy requirements would be great possibilities of camel breeding. In livestock arrangements for desert development should be given merit place that appropriate to its status.

For save genetic camel resources is needed two strategies: conservation *in situ* and conservation ex situ. Within first direction it would be needed to create maximum condition for population in their natural basis (establishment of breeding centers, natural parks and nursery), second direction included cryoconservation of gametes and embryo.

For this work in South-West scientific-industrial center was established the breeding and genetic center that accumulated genetic camel resources of Kazakhstan for further use in breeding work.

3. Perspectives

For perspective are planned biotechnological aspects of investigations for development cyto-, immunological monitoring and establishment of genetic bank, artificial animal breeding, embryo transplantation and using of DNA technologies.

We consider that for join efforts on regional level is needed constant information change, establishment of international basis for mutual discussion of actual problems and to accept solution under policy issues that would be regulated the access to genetic resources and technologies for significant camel product growth.

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Session 2

Camel Keeping and Productiveness

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Desertification Combat and Food Safety
B. Faye and P. Esenov (Eds.)
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Productivity Potential of Camels

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Abstract. If it is agreed that camel has the ability to produce more milk than cow in similar conditions. However, the camel milk productivity is not well known. Data from the literature are scarce and mainly issued from observations in research station, more rarely from pastoral areas where performance monitoring is not common. Elsewhere, the data are not homogeneous from one author to another: mean daily yield, total yield per lactation, herd average… So, the comparisons are not easy. Furthermore, a high variability of reported productions appears which lead to suppose a potential for the selection on that criterion. This selection is possible but rarely achieved except in Soviet Union time for dromedary and Bactrian camels.

The world production of camel milk is officially estimated to 1.3 million tons in 2002. However, according to the high level of self-consumption and of the individual potential, probably this production could be higher (i.e. 5.4 millions tons). The individual production varies between 1000 and 12000 litres per lactation according to some sources. The lactation curve is similar to bovine with a better persistence. The lactation length is very variable (from 8 to 18 months in general), i.e. longer than for dairy cattle in similar conditions. Obviously, the feeding and seasonal conditions have an impact on those performances. Some intensified systems occurring in many places showed good prospects in camel milk production to supply populations from arid lands.

Introduction

For the general public, for funding agencies and policy makers, the camel is poorly associated to high productivity except for packing and racing activities. The potential in meat and milk production is not known as a possible activity for this species. This misunderstanding could be attributed to two features: (1) in the past, the camel dairy production was mainly focused for self consumption or, in case of extra production, for gift to the poorest of for the guests, (2) on literature basis, a few references are available in the international scientific community, even if recent data are more reliable than in the past.

The published results on camel dairy production are mainly from observations achieved in experimental station, more rarely from pastoral zones. In fact, it is quite difficult to perform dairy production monitoring in traditional farming system where animals are commonly submitted to a high mobility. Elsewhere, the measurement procedures are rarely mentioned or set up in standard manner and can change fro one author to another. Finally, the available publications give some results as daily average quantities, total lactation yield or year yield, herd average, after camel calf suckling or not. So, the comparisons between authors are not easy. Finally, even if the camel scientists and producers are able to attribute a high dairy potential to the camel, further investigations are necessary to propose an objective outcome of this potential. The older reference on camel dairy production dated in 1854 [13]. Since that time, the number of hard references on this subject does not overpass one hundred papers et most of them came from soviet literature from fifties and sixties, poorly available for international scientific community [37].

Table 1. World camel milk production (Source : FAO, 2002).

Afghanistan	8100
Algeria	8000
Saudi Arabia	89000
China	14400
Djibouti	5900
Arab Emirates	33400
Eritrea	5100
Ethiopia	22450
Iraq	672
Kenya	25200
Libya	2000
Mali	54900
Morocco	3900
Mauritania	21500
Mongolia	1000
Niger	10800
Qatar	13300
Somalia	850000
Sudan	82250
Chad	21800
Tunisia	1000
Yemen	9500
Total	**1 283 672**

1. The World Camel Milk Production

Before this paper evoke individual performances, the present chapter will place the camel milk production into the world statistics. The cow milk represents approximately 85% of the whole milk produced and consumed in the world. The she-camel production has a marginal place (less than 2%) far away behind the buffalo or the sheep and goat. With a camel world population which is 70 times less important than the cattle population, this difference could not be astonished. From after the FAO statistics, the camel milk production in the world, both for dromedaries and Bactrian camels, was 1 283 672 tons in 2002 (table 1).

First, these data were not complete, because data from Central Asia and from some countries in Near- and Middle-East are missing. Second, a gap can be observed between the estimated population and the announced production, as for example in Sudan where the camel population is the half of the Somalian population for a milk production 10 times lower.

A different assessment could be proposed by the extrapolation of the expected production for a she-camel. The camel world population is around 20 millions heads (this number is probably under-estimated), the proportion of lactating camels is around 18% [16] and the mean production could be estimated at 1500 litres per year. So, the world production could be estimated to 5.4 millions tons from which 55% is taken by the young camel. In fact, there is a strong uncertainty on the world camel milk production all the more as an important part of this milk removed from the market sector.

2. The Milk Potential of the Camel

The estimations of milk yield in camel available in the literature mentioned the produced quantities within lactation or in a year. In most of the case, the authors do not specified if

these yield include or not the part taken by the young camel which represents about 40% of the whole production, even sometimes 75% in some conditions. At last, the number of milking may change according to the circumstances and the producer's habit, and could have an effect on the whole production [29]. When the number of milking is changing from 2 to 3 per day, the daily increasing of milk production could be 28.5% [23]. So, a high variability is described in literature, and comparisons are not easy.

2.1. Africa

2.1.1. Northern-Africa

In Africa, the references can change according to the studies, the considered breeds and the farming system between 1000 and 2700 litres. For example, in Tunisia [22], the extreme values reported in experimental conditions vary between 942 and 3300 litres for a lactation length between 190 and 404 days. In Libya, Hermas (unpublished data) reported milk yield between 320 and 2139 kg at the Al-Assa station with a mean standard production (305 days of lactation) corresponding to 1016 kg. Araba *et al.* [1], conducted a study on Maghrebi camels from Morocco and reported 935 litres milk yield in 305 days. In Egypt, Yagil [47] reported different results from several observations with a dairy yield between 1500 and 4000 litres. In Egypt, dams maintained on irrigated pasture could yield 15 to 35 litres milk/head per day, while the yield was 3 to 5 litres on desert range [8].

2.1.2. Horn of Africa

In Ethiopia, milk yield of five Dankali camels kept on natural pastures was recorded over a period of 12 months. Mean yield per head was 1123 litres. The peak yield of 404 litres was obtained at day 56 [35]. This quantity is comparable to those reported by Dessalegne [6], in southern Ethiopia with Somali breed, i.e. 1045 litres for 430 days. Former studies performed in Ethiopia by Knoess [29] reported a mean daily yield of seven camels milked twice daily: 6.6 litres, i.e. approximately 2000 litres for a standard lactation. Field [10] estimated daily milk yield of camels in northern Kenya at 21 litres in second week of lactation, falling to 4.8 to 2.2 by the sixteenth week of lactation. In this country, the observations on Somali breed reported by Karue [24] were between 1614 and 2151 litres with an average at 1876 kg for the herd. Gebre-Mariam [12] stated that average daily milk yield of Somali camels ranged between 5 and 6 litres. Hashi [14] found that Somali camels on average produce 800 to 3600 litres during the 9 to 18 months lactation. Kaufman [25] analyzed the three camel husbandry systems of the Rendile, Gabra and Somali pastoralists in Northern Kenya. Considering different proportions of poor, average and good yielding camels in the herds, average milk off take per lactation was 1096, 1400 and 1581 litres for the Rendile, Gabra, and Somali respectively. In two traditional camel calf management systems in Kenya involving 42 multiparous lactating Somali camels, the total milk yield was 2956 litres in the group with camels separated from calves, and 2441 litres in control group [42]. An average of 6 litres milk yield per camel per day under feedlot system was reported by Ibrahim [18]. For Schwartz [39], yield of Somali and Kenyan dromedaries ranges from 1300 to 2500 litres, but with good grazing, their yield may even exceed 3000 litres.

2.1.3. West Africa

In Niger, from data monitored in pastoral area, Saley and Steinmetz [38] estimated the annual milk yield at 1760 litres with 2 milking and 2400 litres withy three, the young camel taking 50% of the whole quantity. The milking quantity of Azbin camel in Niger was estimates at 1187 kg for 366 days lactation length and 1417 kg when the young camel sampling was included [5]. In Chad, the observations in pastoral area [11] put forward a mean

dairy yield at 2280 litres for 12 months. In Mauritania, Martinez [31] reported mean values from 3.1 to 4.3 litres per day in peri-urban camel farms with a mean yield of 684 litres in 6 months between the 3rd and 8th lactation month, the three first months being totally let to the young camel.

2.2. Asia

In Asia, extreme values between 650 and more than 12000 litres are reported, the dromedary camels having a best milk potential than Bactrian camel, but there is a lack of available references for this last species. In Central Asia, crossbred strategies between *Camelus dromedarius* and *Camelus bactrianus* to get hybrids aim to improve the milk production.

2.2.1. India and Pakistan

In India, at the Bikaner station, Khanna *et al*. [28] reported a mean yield at 1655 litres (5.5 litres per day) on dromedary camels, but observations between 2000 and 6000 litres were reported in a review paper [27]. According to Ranjhan [34], a dromedary may produce 8 to 10 litres of milk daily. In Pakistan, Yasin and Wahid [49] found that well fed and well managed dromedaries produced 9 to 14 litres milk daily and 2722 to 3629 litres in lactation period of 16-18 months, while under desert conditions the average lactation yield varied from 1134 to 1588 litres milk in 9 months. Knoess *et al.* [30] collected data on lactation yields of seven dromedaries in Punjab and reported a mean daily yield at 18.7 litres, i.e. 5695 litres for a standard lactation. Yagil [47] said the production in Pakistan was comprised between 1350 and 3600 litres per lactation from different publications. Schwartz [39] reported that heavy camels of Pakistan and India may produce up to 12000 litres milk per lactation. In a camel survey conducted in Balochistan (Pakistan), a total lactation yield ranges from 1250 and 3650 litres with an average of 1800 litres was found [21]. According to Iqbal [19], mean milk yield of Punjabi camel was found to be 4260 litres.

2.2.2. Near and Middle-East

In Emirates, the average set around 2000 litres per lactation [33]. Sohail [43] reported that on average, Arabian camels can produce up to 2275 litres of milk per year. Shareha [41] reported in Syria 7.3 to 12.2 litres daily when the udder was completely milked. According to Qreshi [32], on average a camel my produce 8 to 20 litres milk a day, but under intensive management conditions, it may produce from 15 to 40 litres daily. In Koweit, a good, a medium and a poor milker can produce 9030, 3185 and 805 litres respectively in 350 days [17]. In Saudi Arabia, the average milk yield range from 2.4 to 7.6 litres daily [3]. El-Naggar [9] reported that camel can yield about 2700 to 3666 litres per lactation.

2.2.3. Central Asia and China

In Turkmenistan (Saparov, unpublished results), precise measures showed that Arvana camel, recognized for their milk potential, may produce 5000 to 6000 litres per lactation. Yagil *et al.* [48] asserted that yield to 8200 litres, even 12000 litres in intensive conditions may be possible. Bactrian camels seem to have a lower milk potential. The average milk yield is only 800 to 1200 litres. In China, the total lactation yield varies between 500 and 1254 litres [44].

Finally, available data on camel milk production potential at the world level are partial and the proposed estimations stay often approximate, especially in Africa. However, the productivity potential seems higher than for cow in similar climatic and feeding conditions. In Ethiopia for example, *Afar* pastoralists which rear cattle and camel simultaneously, got an average daily milk yield of 1-1.5 litres with *afar* cow and 4-5 litres for *Dankali* camel.

According to Schwartz and Dioli [40], in the Horn of Africa, the milk productivity related to live weight of the animal was higher in camel (250 kg/Tropical Livestock Unit/year) than in small ruminant (220 kg) and than in zebu cattle (100 kg).

3. Genetic Variability and Lactation Characteristics

The genetic variability seems very important and let suppose high possibilities for selection. For example, in Somalia, *Hoor* breed may produce 8 litres per day for 8-16 months lactation i.e. around 2000 litres per lactation. *Sifdaar* breed may produce 6 litres on average for 12 months (1550 litres per lactation), and *Eydimmo* breed is able to produce 4 litres only for 6-12 months, i.e. a production of 1000 litres for a lactation [15]. In India, comparisons were achieved in Bikaner station between *Bikaneri*, *Kachchi* and *Jaisalmeri* breeds with mean yield at 4.19 litres, 3.94 litres and 3.72 respectively [36]. Potential of milk production was reported on 4 phenotypes of Arabian camels for three consecutive lactations, and the milk yield was compared. *Malhah* breed produced more milk (9.33 kg per head), then *Wadhah* breed (8.94), *Safah* breed (8.13) and *Hamrah* breed (6.83). A maximum of 18.3 and 14 kg per head was observed respectively in *Malhah* and *Wadhah* breed [20].

Generally, Asian breeds are considered to have a higher milk potential than African breeds. However, in that field, information is partial. Probably, some breeds may be considered as milk breeds, but selection pressure was low in camel species. Within breed variability is probably very high which let suppose a possible improvement of milk potential in some breeds.

The shape of lactation curve in dairy camel is comparable to cow [35]. The peak occurs at 2-3 months and may reach 5 to 6 litres for a total lactation yield between 1800 and 2000 litres, 8-10 litres when the total lactation yield is 3000 to 3500 litres. The persistence coefficient which expresses the ratio between the milk yield at month + 1 on the previous month is high, generally up to 80% according to available data.

Lactation length may change between 8 and 18 months. It seems to be under the dependence of some practices as the milking or suckling frequency. The milking frequency could be two to six times daily [7]. The milk down induction necessitates the presence of the young camel at the teat. This presence contributes to the maintenance of milk production of the dam. As for the cow, the highest part of expulsed milk during milking or suckling has a cistern origin rather than alveoli cells origin. So, the milk way down may be obtained by the start suckling of the young or by ocytocin injection [2]. Others subterfuges could be proposed by the farmers in case of stillbirth or calf mortality as the introduction of a puppet recovered with the camel calf skin, the adoption or vaginal blowing [4].

Feeding plays an important role on the lactation length and yield. In good feeding conditions, the lactation lengthy may change from 8-12 months up to 16-18 months. Anyway, the differences between breeds could be attributed sometimes to differences in feeding conditions rather than strictly genetic factors. The duration of the lactation is on the dependence of gestation status of the dam also. First, the lactation could inhibit the ovarian activity and then to delay the reproduction time. Second, the end of gestation may lead to a milking refusal for the dam. Generally, the lactation length increases with the calving interval. However, lactation and gestation are not incompatible.

4. Some Variation Factors

Variation factors in camel are similar to those reported in other species. Some date are available in the scientific literature (genetic, quality and quantity of available foods, milking frequency, parity, health status).

4.1. Effect of Climatic and Feeding Factors

Camels are depending of natural resources most of the time. The feeding availability is generally linked to the climatic conditions (heat, humidity) which have obviously an effect on milk production. The difference in milk yield according to the calving season could be up to 50%: milk performances are lower at the end of the dry season than in rainy season [28]. The milk yield seems to be not affected by water shortage. In Israel, Yagil and Etzion [46] observed a continuing production in camels after 10 days dehydration followed by an *ad libitum* drinking then 10 days dehydration again. In a previous observation, 6 camels continued to produce 6 litres per day during hot season with watering once a week [45].

4.2. Effect of Parity

As for other dairy animals, milk yield in camel tends to increase with the parity. However, as the lactation length could be important, data are scarce and limited to very little consecutive lactation. From Ismail and Al Mutairi [20], the optimum may be reached at the second or third lactation.

4.3. Effect of Health Status

Most of the parasites (trypanosoma, internal parasites, ticks and mange) may have cross reaction with milk yield. In pastoral zone, the use of classical veterinary inputs for parasitic disease prevention contributes to 65% milk production increasing [42].

Conclusion

The contribution of the camel to the world milk supply is marginal, but essential for human populations in arid and semi-arid lands, in one hand to satisfy the human needs in communities culturally attached to camel products and to contribute to the food safety, in other hand to stimulate the local economy by the maintain of an agricultural activity in desert margins. However, the available data on production potential of the camels are not sufficient. A great variation in camel milk production may be attributed to the methods employed to determine yield [26]. Further investigations and probably standardisation of the methods are necessary to point out the place of camel milk production in the food security of desert areas in the world.

References

[1] **Araba A., El-Aich A., Ghafri K.M., Ahouate L.,** 1998. Characterisation of growth and milk production of camels fed basically shrubs. Third annual meeting for Anim. Prod. Under arid conditions, 2-3 may 1998, Al-Ain, UAE.

[2] **Balasse M.,** 2003. Keeping the young alive to stimulate milk production? Differences between cattle and small stock. Anthropozoologica, 37, 3-10.

[3] **Basmaeil S.M., Bakkar M.N.,** 1987. Milk production of Majaheem camels in Saudi Arabia during the first lactation season. Proc. Saudi boil. Soc. Jeddah, 10, 75-79.

[4] **Bernus E.,** 1992. Le lait de chamelle. *In:* "Relations Homme-animal dans les sociétés pastorales d'hier et d'aujourd'hui". Festival animalier International de Rambouillet. 25-26 sept 1992, Actes du Colloque, 165-172.

[5] **Chaibou M., Faye B.,** 2003. Production laitière des chamelles Abzin élevées par les touaregs nomades du Niger. Atelier Int. sur le lait de chamelle en Afrique. FAO-CIRAD-KARKARA, Niamey (Niger), 5-8/11/03.

[6] **Dessalegne B.,** 1985. Milk offtake, growth and feeding habits of camels in the southern rangelands of Ethiopia. Publ. ILCA, Addis-Abeba (Ethiopie), 23 p.
[7] **Dioli M., Schwartz H.J., Stimmelmayr R.,** 1992. management and handling of camels. In the one-humped camel in eastern Africa. Verlag Josef margrave, Germany.
[8] **El-Badawi A.Y.,** 1996. The possibilities of using camels in the new reclaimed lands. First meeting of the national committee for camel research in the Arab republic of Egypt, 16 nov. 1996, Cairo (Egypt).
[9] **El-Naggar M.A.,** 1998. The camel is the goal animal in arid zones and drylands for the coming 21st century. Third annual meeting for Anim. Prod. Under arid conditions, 2-3 may 1998, Al-Ain, UAE.
[10] **Field C.R.,** 1979. Camel growth and milk production in Marsabit district, northern Kenya. Proc. Workshop on camels, 18-20 dec. 1979, Khartoum (Sudan).
[11] **Ganda K., Buron S.,** 1992. Projet camélin de Biltine. Rapport de synthèse. N'Djamena, Tchad, 129 p.
[12] **Gebre-Mariam A.,** 1987. Livestock production and its socio-economic importance among Afar camels of Northeast Ethiopia. Camel forum working paper n°16. Uppsala, SOMAC/SIAS publ. (Sweden).
[13] **Gouhaux M.,** 1854. Rapport sur le dromadaire. Bull. Soc. Imp. Centrale de Méd. Vét. Rec. Méd. Vét., 1, 404-416.
[14] **Hashi A.M.,** 1993. The role of camel production in drylands with reference to Somalia. The multipurpose camel. EPOS publ., Uppsala, Sweden.
[15] **Herren U.J.,** 1993. Cash from camel milk: the impact of commercial camel milk sales on Garre and Gaaljacel camel pastoralism in southern Somalia. *In:* « the multi-purpose camel: interdisciplinary studies on pastoral production in Somalia. ». Anders Hjort of Ornas (Ed.), EPOS publ., Uppsala University, Sweden, 57-74.
[16] **Hjort af Ornas,** 1988. Sustainable subsistence in arid lands: the case of camel rearing. *In:* « camels in development ». Ed. Hjort af Ornas, SIAS, Uppsala, Suède.
[17] **Ibnoaf M.,** 1987. Towards a better understanding of our domestic livestock: camels of Kuwait. Technical report, Kuwait Institute for scientific Research, Safat, Kuwait.
[18] **Ibrahim A.,** 1990. Potentialities for milk production from Sudanese she-camels in feedlot system. Proc. Int. Conf. camel Production and improvement, 10-13 dec., 1990, Tobruk, Lybia.
[19] **Iqbal A.**, 1999. Studies on some of the productive, reproductive and behavioural aspects of camel in Pakistan. PhD thesis, Univ. Agri., Faisalabad, Pakistan.
[20] **Ismail M.D., Al Mutairi SE,** 1998. Milk production potential of dairy camels in northern Saudi Arabia. *In:* actes du colloque : dromadaires et chameaux, animaux laitiers, Nouakchott, Mauritanie, 24-26 oct. 1994, CIRAD-Montpellier, coll . Colloques, 35-40.
[21] **Jasra A.W., Aujla K.M.,** 1997. Socio-economic profile of camel herders in SW mountainous areas of Pakistan. CARDN Scientific report n°1. NADRI publ., Islamabad (Pakistan).
[22] **Kamoun M., Ellouze S., Grondin J., Quinizi Ch.,** 1990. The tunisian experience in camel milk production and processing. Proc. Int. Conf. camel Production and improvement, 10-13 dec., 1990, Tobruk, Lybia.
[23] **Kamoun M.,** 1995. Le lait de dromadaire : production, aspects qualitatifs et aptitude à la transformation. Options méditerranéennes. Séries séminaires n°13, 81-103.
[24] **Karue C.N.,** 1998. The dairy characteristics of the Kenyan camel. *In:* actes du colloque : dromadaires et chameaux, animaux laitiers, Nouakchott, Mauritanie, 24-26 oct. 1994, CIRAD-Montpellier, coll . Colloques, 55-60.
[25] **Kaufmann B.,** 1998. Analysis of pastoral camel husbandry in northern Kenya. Margraf Verlag, Weikersheim, germany.
[26] **Khan B.B., Iqbal A.,** 2001. Production and composition of camel milk. Review. Pak. J. Agri. Sci., 38, 64-68.
[27] **Khanna N.D.,** 1986. Camel as a milk animal. Indian farming, 36, 39-40.
[28] **Khanna N.D., Sahani M.S., Rai A.K.,** 1998. The camel as a milk animal in indian experience. *In:* actes du colloque : dromadaires et chameaux, animaux laitiers, Nouakchott, Mauritanie, 24-26 oct. 1994, CIRAD-Montpellier, coll . Colloques, 95-100.
[29] **Knoess K.H.,** 1977. Le chameau producteur de viande et de lait. Rev. Mondiale de Zootech., 22, 39-44.
[30] **Knoess K.H., Makhudum A.J., Rafiq M., Hafeez M.,** 1986. Milk production potential of the dromedary with special reference to the province of Punjab, pakistan. World Anim. Rev., 57, 11-21, FAO, Rome (Italy).
[31] **Martinez D.,** 1989. Note sur la production de lait de dromadaire en secteur périurbain en Mauritanie. Rev. Elev. Méd. Vét. Pays trop., 42, 115-116.
[32] **Qreshi M.H.,** 1986. The camel. Seminar on camel Production and health, 20-23 oct., 1986. FAO, Rome.
[33] **Quandil S.S., Oudar J.,** 1984. Etude bactériologique de quelques cas de mammites chez la chamelle dans les Emirats Arabes Unis. Rev. Med. Vét., 135, 705-707.
[34] **Ranjhan S.K.,** 1997. Animal nutrition and feeding practices. Vikas Publ. House Ltd, New Dehli (India).

[35] **Richard D., Gerard D.,** 1985. La production laitière des dromadaires Dankali (Ethiopie). *In:* Conference internationale sur les productions animales en zones arides. 1985/09/07 –12, Damas (Syrie), Maisons-Alfort, CIRAD-EMVT, 16 p.

[36] **Sahani M.S., Rahinasa Bapathy M., Gorakhmal D., Khanna N.D.,** 1998. Effect of milking techniques on milk production potential in Indian camel breeds under farm conditions. *In:* Proc. of the third annual meeting on animal production under arid conditions, U.A.E Univ., 1, 52-58.

[37] **Saint-Martin G.,** 1990. Bibliographie sur le dromadaire et le chameau. Coll. Etudes et synthèse, Publ. IEMVT, Maisons-Alfort.

[38] **Saley M., Steinmetz P.**, 1998. Approche quantitative de la production laitière destinée à la consommation humaine, répercussion sur la croissance du chamelon. Etude réalisée en milieu traditionnel sahélien. *In:* actes du colloque : dromadaires et chameaux, animaux laitiers, Nouakchott, Mauritanie, 24-26 oct. 1994, CIRAD-Montpellier, coll . Colloques, 87-94.

[39] **Schwartz H.J.,** 1992. Productive performance and productivity of dromedaries. Anim. Res. Dev., 35, 85-98.

[40] **Schwartz H.J., Dioli M.,** 1992. The one-humped camel in eastern-Africa. Editions Verlag, Weikersheim (Allemagne), 282 pp.

[41] **Shareha A.M.,** 1985. Effect of the presence of early weaning on milk secretion and growth rate of the young dromedary camels. Proc. Int. Conf. Anim. Prod. Arid zones, 7-12 dec. 1985, Damascus, Syria.

[42] **Simpkin S.P., Rowlinson P., Tullu D., Lesorogol P.,** 1997. A comparison of two traditional camel calf management systems in Kenya and implications for milk production. J. Camel Pract. Res., 4(2), 229-234.

[43] **Sohail M.A.,** 1983. The role of the Arabian camel in animal production. World Rev. Anim. Prod., 19, 38-40.

[44] **Xhao X.X.,** 1994. Milk production of Chinese Bactrian camel. *In:* actes du colloque : dromadaires et chameaux, animaux laitiers, Nouakchott, Mauritanie, 24-26 oct. 1994, CIRAD-Montpellier, coll . Colloques.

[45] **Yagil R, Etzion Z., Ganani J.,** 1979. Camel thyroid metabolism: the effect of season and dehydration. J. Appl. Physiol., 45, 540-544.

[46] **Yagil R., Etzion Z.,** 1980. The effect of drought conditions on the quantity of camel's milk. J. Dairy Sci., 47, 159-166.

[47] **Yagil R.,** 1982. Camels and camel milk. *In:* « Animal production and health » paper n°26.,1-69 Publ. FAO, Rome.

[48] **R., Zagoski O., Van Creveld C.,** 1998. Science and camel's milk production: some keys for nutrition and marketing. *In:* actes du colloque : dromadaires et chameaux, animaux laitiers, Nouakchott, Mauritanie, 24-26 oct. 1994, CIRAD-Montpellier, coll . Colloques, 79-86.

[49] **Yasin S.A., Wahid A.,** 1957. Pakistan camels: a preliminary survey. Agri. Pakistan, 8, 289-297.

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Body Lipids and Adaptation of Camel to Food and Water Shortage: New Data on Adipocyte Size and Plasma Leptin

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Abstract. The ability of camels to cope with food or water shortage is exceptional, thanks to several mechanisms of adaptation, including mobilization of body fat reserves during underfeeding and regeneration when food is available.

In camel, the adipose tissues are mainly located in the hump (external) and around the kidney (internal perirenal fat, PF) and consist mainly of cells able to store lipids (adipocytes). However, the measurement of adipocyte size was scarcely performed, and no data are available on the variations of plasma leptin, an hormone which is secreted by adipocytes in mammalian species and could play a major role in the regulation of energy homeostasis.

Recent experiments showed that the mean adipocyte size is similar between hump and PF, and was 100-700 picoliters in 70 adult male or female camels, in the range of values observed in cattle and sheep. Hump or PF weights were positively correlated and better explained by adipocyte size than number. Hump adipocyte size was positively correlated to hump height-hemicircumference and to hump lipid content. Hump biopsies during experiments with different levels of food or water allowance showed that adipocyte size decreased during a 2-month underfeeding, and this decrease was more marked when camels were previously overfed, whereas adipocyte size was not affected by 3 weeks of water deprivation. However, dehydration increased fat mobilization, with an increase in plasma non-esterified fatty acids and a decrease in hump lipid content.

A radioimmunoassay was developed for camel leptin, using antibodies raised against sheep leptin. Plasma leptin concentration was 2-9 ng/ml, and positively correlated to hump lipid content or adipocyte size, but less closely than in cattle. It was not affected by underfeeding nor overfeeding, contrary to what was observed in cattle and sheep. Plasma leptin increased steadily (+ 20 %) during 3 weeks of water deprivation, and returned rapidly to the control level after 6 hours of rehydration. Further studies will precise the role of leptin in the adaptation of camels to desert conditions.

Keywords. Camel, adipose tissue, hump, adipocyte, leptin, underfeeding, dehydration

Introduction

The ability for the ruminants to mobilise and to regenerate the fat reserves is widely used in farming management to take into account the variations in feeding availability and in

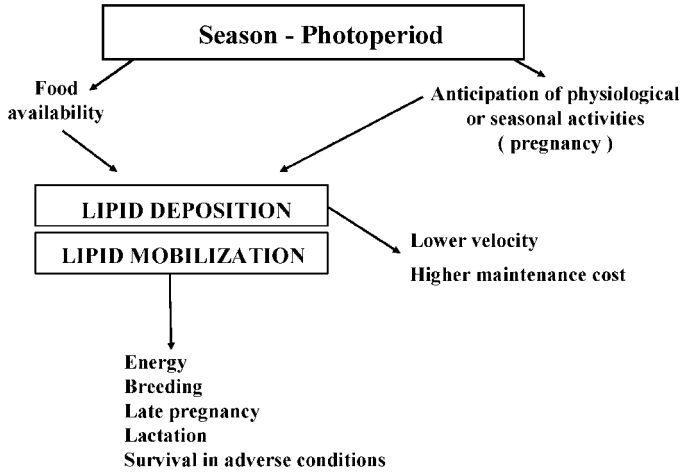

Figure 1. Physiological roles for body fat in mammals (*Chilliard, 1989*).

changes of animal requirements along the production cycle. During underfeeding periods, ruminants use their fat stores to maintain their productivity, and/or to survive, by mobilizing adipose tissue accumulated previously during overfeeding periods [12].

The ability of camels to cope with food or water shortage is the result of a long evolutionary process in natural conditions where food/water availability seasonally and sharply fluctuates [42,41]. Lipid deposition and mobilization contribute to the physiological strategy to anticipate the needs for pregnancy, lactation or food shortage [11] (Figure 1). In arid conditions, all the adaptive mechanisms and especially either energy sparing or body fat mobilization strategies are of considerable importance in determining reproductive performance. For example, Tibary and Anouassi [40] have observed a lack of ovarian activity in she-camel with very low body score. Usually, the female in all ruminant species losses a part of her fat storage after calving to assure the milk production, because its intake ability is not sufficient to cover the nutrient needs for mammary secretion. The fat deposition occurs generally after 2 or 3 months beyond lactation peak and becomes important after drying. The fat storage must be enough at the next calving to allow a new reproductive cycle. However this cycle can be disturbed by seasonal food shortage or diseases, leading to reproductive failure. So, the management of fat storage, that could be appreciated by a body condition score (BCS) [22], is an important tool for the farmer and the veterinarian to assume the best opportunity for reproduction.

The mechanisms of resistance to dehydration, or to the mineral deficiency are well documented in camels [3,4]. To our knowledge, no studies concerning the mechanism of adaptation to extreme variation of feeding are available and data on body fat changes during underfeeding are extremely rare in camels. The most important part of the adipose tissue is located in the hump (on average 44 % of the whole fat according to unpublished results from Tunisia) and around the kidney (perirenal fat, PF) or viscera, but fat storage can occur on other parts of the carcass (shoulder, sternum, flank, ribs, thigh and neck) [26], and in the recto-genital zone [31]. Adipose tissues consist mainly of cells (adipocytes) able to store lipids in their cytoplasm and no data were available in camels until the 2000's, except observations in one young bactrian camel [30]. In ruminants, the weight of adipose tissue results mainly from the combination of adipocyte number and size [33,36], and consider-

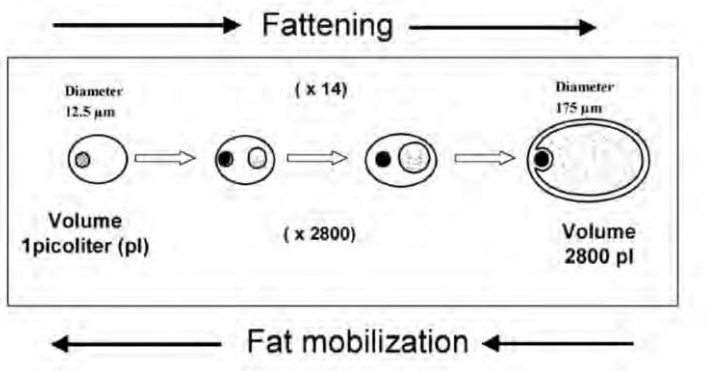

Figure 2. The size of adipocytes depends on the quantity of intracellular stored fat.

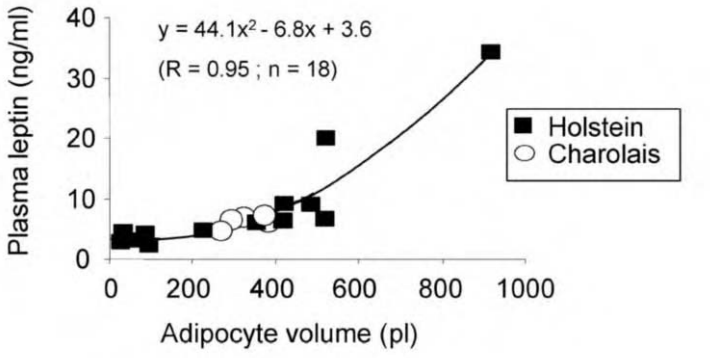

Figure 3. Adipocyte size and plasma leptin in cattle (*Delavaud et al., 2002*).

able variations of adipocyte size can result from respective changes in lipid deposition (lipogenesis) and mobilization (lipolysis) within adipocytes [13] (Figure 2).

Leptin, the *ob* gene product, is a hormone secreted mainly by adipose cells of white adipose tissues, which was discovered in 1994 in obese rodents. This hormone participates to the regulation of energy metabolism and homeostasis, by inhibiting feed intake and stimulating energy expenditure, and it is also probably involved in the regulation of reproduction and in immune responses of mammals [2]. In cattle and sheep, as in rodents and humans, plasma leptin is higher in fat animals [16,17] (Figure 3) and, for a given animals at constant fatness, leptin gene expression and plasma leptin decrease during short term underfeeding [7,17] (Figure 4). This decrease in plasma leptin plays an important role in the physiological adaptations which allow the survival of underfed rodents [1] and similar events probably occur in ruminants [14,20]. Furthermore, bovine plasma leptin increases during late pregnancy and decreases during early lactation, and these variations are partly independent of simultaneous changes in body fatness and energy balance [27,28,32,29].

The aim of this paper is to review recent published and unpublished data from 3 experiments conducted jointly by our 3 laboratories on the variations of adipocyte size/number, and of plasma leptin in camels, and the nutritional and physiological factors which regulate them (Table 1).

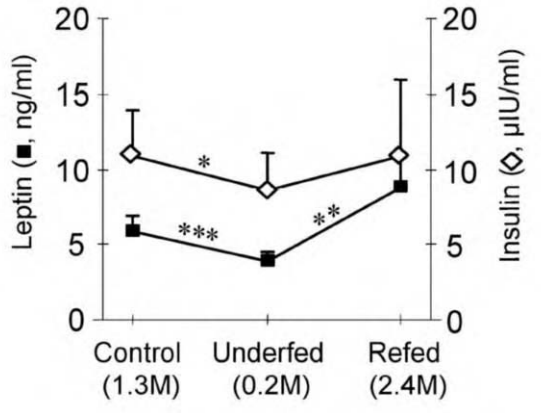

Figure 4. Plasma leptin and insulin in underfed-refed cows (*Delavaud et al., 2002*).

Table 1. Experimental studies on dromedary camel lipid metabolism during the years 2000-2003 (*3 Institutes in Morocco and France, funded in part by the PRAD programme N°01/04*).

Experiment 1
46 adult camels (28 females and 18 males)
(27 camels < 4 year-old)
Slaughtering and measurements on hump fat and perirenal fat (PF)
Experiment 2
14 she-camels
Underfeeding/Overfeeding cross-over design
Hump biopsies (n = 14 x 5) and blood sampling
Experiment 3
12 camels
Dehydration/Rehydration protocol
Hump biopsies (10 x 2) and blood sampling

1. Adipocyte Size and Number as Predictors of Adiposity

A first study (Experiment 1) was done in 46 adult camels (28 females and 18 males, 42 % of which were 4-year old or more) at slaughter [23,24] (Table 2). Hump weight (4-40 kg) and PF weight (0.2-1.4 kg) were positively correlated (r = 0.57), although a lower correlation (r = 0.33) was observed between the mean adipocyte volumes in these two adipose tissues (Figure 5). The mean volumes varied largely between animals but were similar in the two tissues, and in the range (100-700 picoliters) observed in cattle [33,34,10,25] and sheep [37,38,7,8]. In each tissue the mean volume of adipocytes was slightly correlated to the tissue weight (r = 0.40), whereas the total number of adipocytes was not. The number of adipocytes tended to be higher in the PF of camels of which were 4-year old or more than in younger ones [24]. These results show that the large inter-individual variability in hump and PF weights (kg or % of the carcass) can not be predicted simply using either the number or the mean volume or the pattern of cell size distribution [23] of their adipocytes. A similar observation was done in sheep [8] although in cattle tailhead subcutaneous adipocyte size was rather well correlated to total body lipids [10,35].

Table 2. Correlations between fatness parameters in dromedary camels[a].

Experiment 1 (n = 46) (*Faye et al, 2002*)	
Hump weight - PF weight	r = 0.57
Hump adipocyte volume -PF adipocyte volume	r = 0.33
Hump weight - hump adipocyte volume	r = 0.40
PF weight - PF adipocyte volume	r = 0.40
Experiments 2 and 3 (n = 90) (*Bengoumi et al 2004a ; Faulconnier et al, 2004*)	
Hump lipid content - adipocyte volume	r = 0.79
Hump hemicircumference - adipocyte volume	r = 0.58
Hump hemicircumference - lipid content	r = 0.44

[a] PF = perirenal fat; hemicircumference = measured from on side of hump to the other side, through the top.

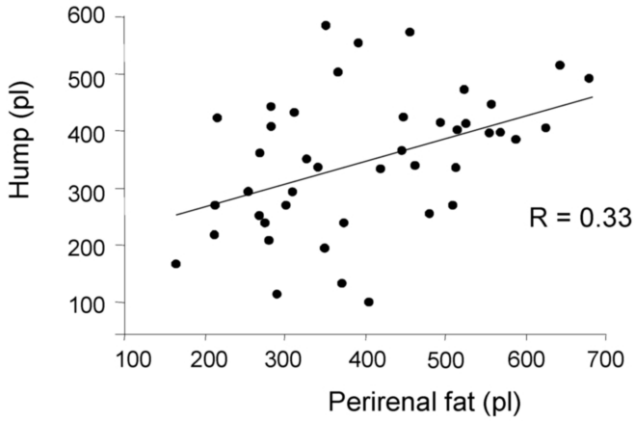

Figure 5. Camel hump and perirenal fat adipocyte volumes in Experiment 1 (n = 43) (*Faye et al., 2002*).

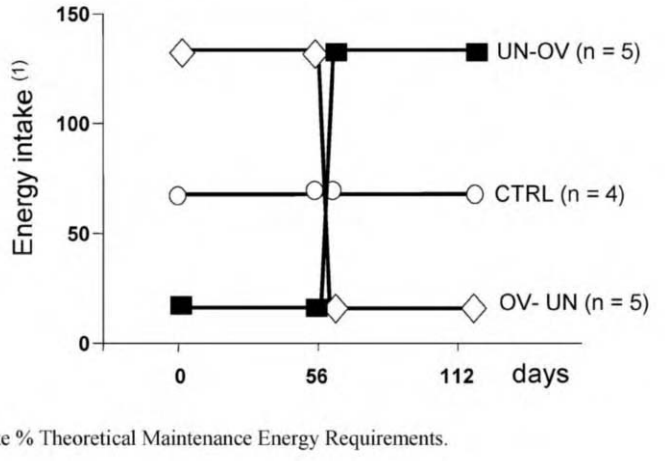

Figure 6. Underfeeding/Overfeeding design in Experiment 2 (*Bengoumi et al., 2004a*).

Adipocyte size was also studied in vivo from hump biopsies in camels during either underfeeding-overfeeding (UN-OV) (Experiment 2) [5] (Figure 6) or dehydration-rehydration (Experiment 3) [6,21] experiments, in which the hump weight was simultaneously

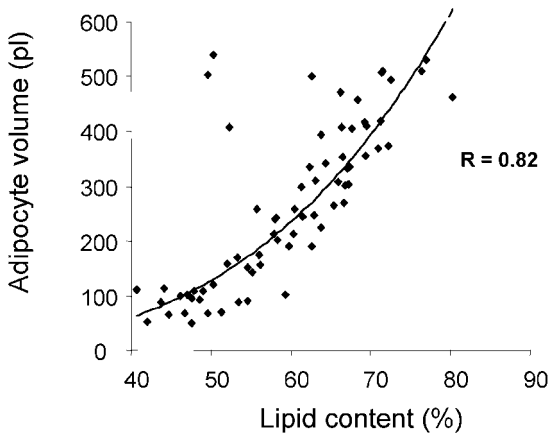

Figure 7. Camel hump adiposity parameters in Experiment 2 (n = 70) (*Bengoumi et al., 2004a*).

estimated from its external hemicircumference as it could be seen from behind the camel [24]. In Experiment 2 (70 biopsies from 14 camels) hump adipocyte mean volume was correlated to hump hemicircumference (r = 0.63) and lipid content (r = 0.82; Figure 7), and in Experiment 3 (20 biopsies from 10 camels) these correlations were r = 0.67 and 0.61, respectively [21]. Similar values were observed when the 2 experiments were pooled (Table 2). Inter-experiment inter-individual variations (n = 24 camels in the 2 trials before experimental treatments) showed also significant correlations between hump adipocyte mean volume and either hump "height" (r = 0.70) or lipid content (r = 0.59). Thus, it can be concluded that for a given animal, changes in hump adipocyte volume during underfeeding-overfeeding could be predicted with a rather good precision from changes in the lipid content of hump biopsies, whereas the estimation of between-camel adipocyte volume variation is less precise, either from hump lipid content or from external measurements of hump hemicircumference.

2. Development of a Leptin RIA for Camels

It was shown in cattle and sheep that a commercial multispecies RIA kit was less efficient that a specific RIA developed from antibodies raised against ovine recombinant leptin and adapted to either ovine, bovine or goat plasma [16,17]. In particular, peripartum leptin changes were not well detected in cattle using the multispecies kit [18]. For these reasons, several different rabbit anti-ovine leptin antibodies were tested [19] in order to choose the one giving the best parallelism between serial dilutions of camel plasma and the standard curve of ovine recombinant leptin (to insure that cross-reactivity was good). Simultaneously, the composition of the RIA mixture used for ovine plasma [16] was modified in order to optimise the precipitation step of the RIA in camels, and to insure good reproducibility of the measurement.

3. Relationship Between Plasma Leptin and Adiposity

Plasma leptin in 24 camels, before experimental treatments in both Experiments 2 and 3, was 2-9 ng/ml, and positively correlated (Figure 8) to hump lipid content (r = 0.42) or

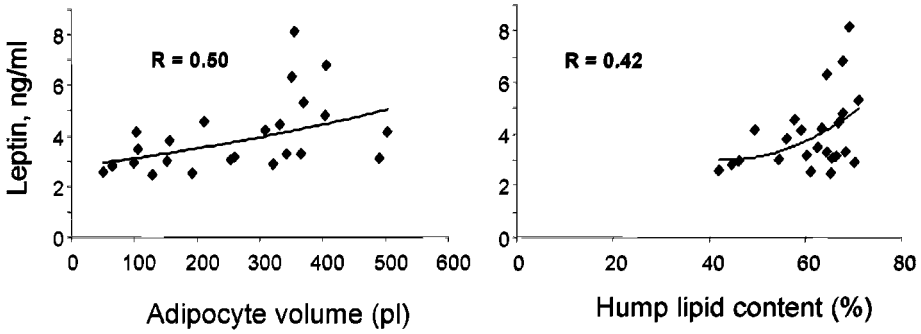

Figure 8. Camel plasma leptin and hump adipocyte volume or lipid content (Exp. 2 and Exp. 3, n = 24 camels during pre-experimental periods) (*Delavaud et al., 2004b; Chilliard et al., 2004*).

Table 3. Changes in camel hump adipocyte volume (picoliters) *(Bengoumi et al, 2004a*).

Experiment 2	Period 1 (0-56d)	Period 2 (56-112d)
Group CTRL	-16	+53
Group OV-UN	**+115***	**-86**
Group UN-OV	-17	**+71**

* P < 0.05 ; CTRL = control feeding ; OV-UN = overfeeding (period 1) and then underfeeding (period 2); UN-OV = underfeeding (period 1) and then overfeeding (period 2) (see Figure 6 for more details).

adipocyte mean volume (r = 0.50), but less closely than in cattle [17]. In camels, plasma leptin does not seem to be related to body weight or BCS (or hump external height-semicircumference), contrary to what was observed in sheep [16] and cattle [17,29]. These first results thus suggest that in the camel plasma leptin is less related to body fatness than in other ruminants.

4. Effects of Underfeeding-Overfeeding on Adipocyte Volume and Plasma Leptin

During Experiment 2 [5], 14 non-pregnant dry 10 to 15-year old female camels were used. Four camels received a control diet covering 68 % of theoretical maintenance energy requirements (MER) during 4 months (CTRL), 5 camels were underfed during 2 months at 17 % MER and then overfed at 134 % MER during 2 months (UN-OV), and 5 other camels were overfed and then underfed (OV-UN) (Figure 6).

The overfeeding tended to have a positive effect, especially in the OV-UN group, on the mean volume of hump adipocyte volume (Table 3) as was reported in other ruminants [9]. It takes generally a long time after a change in feeding level of ruminants before to observe any significant change in adipocyte size. For example, it was observed [39] that after 4 months of experiment in growing cattle a difference occurred between 1.74 and 0.76 x maintenance levels, but not with 1.43 x maintenance. In adult sheep, no difference was observed after 2 weeks at either 0.22 or 1.90 x maintenance [7]. Thus, the 2-month duration of the periods in the present trial could have been too short to allow to observe fully the potential changes in adipocyte volume.

The negative effect of underfeeding on the adipocyte volume was more important after an overfeeding period (OV-UN group), suggesting that effects of previous recent overfeeding could be more rapidly reversed than when animals were already adapted for a long period to a lower “maintenance” diet, probably because they developed in those conditions

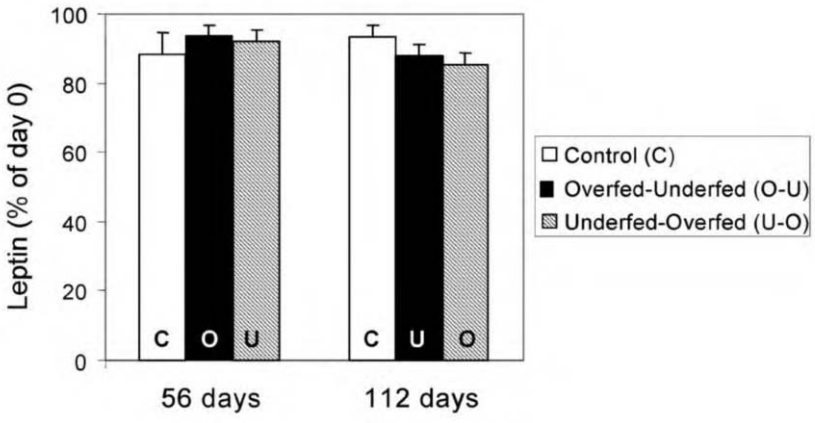

Figure 9. Camel plasma leptin does not change during overfeeding or underfeeding (Exp.2, see Figure 6) (*Delavaud et al., 2004b*).

energy sparing mechanisms to decrease their MER [42]. The small size of the adipocytes of the animals at the beginning of the trial could also explain the non significant effect of underfeeding in the UN-OV group, since fat mobilization is easier in fat animals [13].

Plasma leptin did not change from the beginning to the end of the experiment (7 sampling dates during the 4 months) in all the 3 groups of camels (Figure 9) [19], despite the fact that simultaneously plasma non-esterified fatty acids, which reflect fat mobilization, increased sharply during the first month of underfeeding periods [5] (and unpublished results). Thus, contrary to cattle and sheep in which plasma leptin decreased during short-term (1-3 weeks) underfeeding and increased during overfeeding independently of any change in body fat or adipocyte volume [7,16,17,14], plasma leptin is insensitive to feeding level in camels.

5. Effects of dehydration-Rehydration on Adipocyte Volume and Plasma Leptin

During Experiment 3 [6], 12 non-pregnant dry 12 to 17-year old female camels were used. Six camels were deprived of water (DH) during 23 days and received straw and concentrates and 6 other camels (control, CTRL) received water ad libitum and were pair-fed with the DH group. From day 24, all camels received water and food to cover their MER. During the first 6 minutes of rehydration the 6 camels drank 68-89 liters of water.

Adipocyte mean volume did not change during the dehydration period [21], despite the fact that plasma non-esterified fatty acids increased and hump lipid content decreased slightly (- 3 %) but significantly [6]. Thus there was a mobilization of body fat during dehydration, but the short duration of that mobilization (3 weeks) did not allow to observe any change in the size of the fat cell volume.

Plasma leptin was stable in the control group, whereas it increased steadily during 14 days from the beginning of the dehydration period and then remained 20-25 % higher than in controls during the 3rd week [15] (Figure 10). When camels were rehydrated, plasma leptin returned within 6 hours to the control level. This very significant and rapid response could be related to a role for leptin in the energy and/or mineral homeostasis of camels challenged by dehydration-rehydration periods. Conversely, hormonal and physiological changes during dehydration [4], such as hypothyroidism, hypoinsulinemia, increased body temperature cycles from day to night, increased glycemia, fat mobilization,

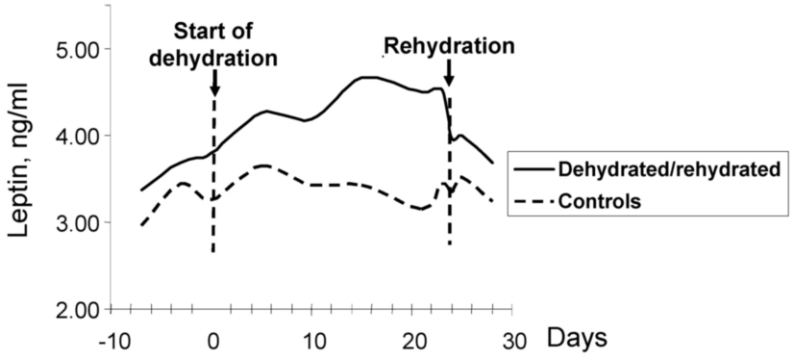

Figure 10. Changes in camel plasma leptin during dehydration and rehydration (Exp. 3 : 6 controls and 6 dehydrated-rehydrated camels) (*Chilliard et al., 2004*).

renin, aldosterone and antidiuretic hormone (ADH) (and decreased renin and ADH and increased aldosterone during rehydration) could play a role in the regulation of leptin secretion by adipocytes or in the leptin turn-over in the body. However, as for other plasma proteins in dehydrated animals, the increase in plasma leptin concentration could be simply due to the haemoconcentration linked to the decrease in body water volume, rather than to a physiological role for leptin in the adaptation to dehydration? There was indeed some parallelisms between leptin and either hematocrit (blood packed cell volume) or, in opposite direction, body weight changes during the dehydration-rehydration periods (results not shown). Further studies, particularly on other plasma proteins, are in progress in our laboratories to enlighten these observations.

Conclusion

The results reviewed and/or presented in this paper on adipocytes and leptin are the first available in camels. They show some similarities with other ruminants for the links between adipocyte mean volume and either body fatness or adaptation to underfeeding-overfeeding. In other respects, plasma leptin seems to be less reactive than in cattle and sheep to changes in either body fatness or short-term feeding level. The significance of the increased plasma leptin concentration during dehydration (passive or active response) remains to be studied.

References

[1] **Ahima R.S., Prabakaran D., Mantzoros C., Qu D., Lowell B., Maratos-Flier E., Flier J.S., 1996.** Role of leptin in the neuroendocrine response to fasting. Nature, 382, 250-252.

[2] **Ahima R.S., Flier J.S., 2000.** Leptin. Annu. Rev. Physiol., 62, 413-437.

[3] **Bengoumi M., Riad F., Giry J., De La Farge F., Davicco M.J., Safwate A., Barlet J.P., 1993.** Hormonal control of water and sodium in plasma and urine of camels during dehydration and rehydration. Gen. Comp. Endocrinol., 89, 378-386.

[4] **Bengoumi M., Faye B., 2002.** Adaptation du dromadaire à la déshydratation. Revue Sécheresse, 13, 121-129.

[5] **Bengoumi M., Tabarani A., Sghiri A., Faulconnier Y., Faye B., Chilliard Y., 2004a.** Effects of overfeeding and underfeeding on body weight, hump size, lipid content and cellularity in the dromedary camel, submitted for publication.

[6] **Bengoumi M., Grech S., Faye B., 2004b.** Effects of dehydration-rehydration on body weight, blood packed cell volume, plasma non-esterified fatty acids and hump external size in the dromedary camel, unpublished results.

[7] **Bocquier F., Bonnet M., Faulconnier Y., Guerre-Millo M., Martin P., Chilliard Y., 1998.** Effects of photoperiod and feeding level on adipose tissue metabolic activity and leptin synthesis in the ovariectomized ewe. Reprod. Nutr. Dev., 38, 489-498.

[8] **Bocquier F., Guillouet Ph., Barillet F., Chilliard Y., 1999.** Comparison of three methods for the in vivo estimation of body composition in dairy ewes. Ann. Zootech., 48, 297-308.

[9] **Chilliard Y., J. Robelin, 1985.** Activité lipoprotéine-lipasique de différents dépots adipeux et ses relations avec la taille des adipocytes chez la vache tarie, en cours d'engraissement ou en début de lactation. Reprod. Nutr. Dev. 25, 287-293.

[10] **Chilliard Y., Rémond B., Agabriel J., Robelin J., Vérité R., 1987.** Variations du contenu digestif et des réserves corporelles au cours du cycle gestation lactation. Bull. Tech. CRZV INRA Theix, 70, 117-131.

[11] **Chilliard Y., 1989.** Particularités du métabolisme des lipides et du métabolisme énergétique chez le dromadaire. Options méditerranéennes, série séminaires n°2, 101-110.

[12] **Chilliard Y., Bocquier F., Doreau M., 1998.** Digestive and metabolic adaptation of ruminants on undernutrition and consequences on reproduction. Reprod. Nutr. Dev. 38, 131-152.

[13] **Chilliard Y., Ferlay A., Faulconnier Y., Bonnet M., Rouel J., Bocquier F., 2000.** Adipose tissue metabolism and its role in adaptations to undernutrition in ruminants. Proc. Nutr. Soc., 59, 127-134.

[14] **Chilliard Y., Bonnet M., Delavaud C., Faulconnier Y., Leroux C., Djiane J., Bocquier F., 2001.** Review: Leptin in ruminants. Gene expression in adipose tissue and mammary gland, and regulation of plasma concentration. Domest. Anim. Endocrinol., 21, 271-295.

[15] **Chilliard Y., Delavaud C., Bengoumi M., Faulconnier Y., Sghiri A., Tabarani A., Faye B., 2004.** Plasma leptin in the camel: development of a RIA procedure, relationship with adiposity and effects of overfeeding-underfeeding or dehydration-rehydration, to be submitted.

[16] **Delavaud C., Bocquier F., Chilliard Y., Keisler D.H., Gertler A., Kann G., 2000.** Plasma leptin determination in ruminants : effect of nutritional status and body fatness on plasma leptin concentration assessed by a specific RIA in sheep. J. Endocrinol., 165, 519-526.

[17] **Delavaud C., Ferlay A., Faulconnier Y., Bocquier F., Kann G., Chilliard Y., 2002.** Plasma leptin concentration in adult cattle: Effects of breed, adiposity, feeding level, and meal intake. J. Anim. Sci., 80, 1317-1328.

[18] **Delavaud C., Agenäs S., Holtenius K., Chilliard Y., 2004a.** Interactions between energy intake level, physiological state and methodology for determination of plasma leptin in bovine species. Reprod. Nutr. Dev., 44, in press.

[19] **Delavaud C., Bengoumi M., Faye B., Tabarani A., Faulconnier Y., Sghiri A., Chilliard Y., 2004b.** Plasma leptin measurement in the dromedary Camel and its relationships to adiposity and feeding level, International Conference on Farm Animal Endocrinology, Budapest, Hungary, 4-6 July, 2004, in press.

[20] **Faulconnier Y., Delavaud C., Chilliard Y., 2003.** Insulin and (or) dexamethasone effects on leptin production and metabolic activities of ovine adipose tissue explants. Reprod. Nutr. Dev., 43, 237-250.

[21] **Faulconnier Y., Bengoumi M., Grech S., Faye B., Chilliard Y., 2004.** Effects of dehydration-rehydration on hump adipose tissue cellularity in the dromedary camel, unpublished results.

[22] **Faye B., Bengoumi M., Cleradin A., Tabarani A., Chilliard Y., 2001a.** Body condition score in camel : a tool for management of reproduction. In: Proceedings of the International Twin Conference on Reproduction/Production in Camelids. University of United Arab Emirates, Al-Ain, 11-13 November 2001. 7 pp.

[23] **Faye B., Bengoumi M., Viateau E., Tourret M., Chilliard Y., 2001b.** Adipocyte patterns of adipose tissue in camel hump and kidney. J. Camel Pract. Res., 8, 29-33.

[24] **Faye B., Bengoumi M., Messad S., Chilliard Y., 2002.** Estimation des réserves corporelles chez le dromadaire. Rev. Elev. Méd. Vét. Pays Trop., 55, 69-78.

[25] **Gagliostro G., Chilliard Y., 1991.** Duodenal rapeseed oil infusion in early and midlactation cows. 2. Voluntary intake, milk production and composition. J. Dairy Sci., 74, 499-509.

[26] **Hidane K., Moujjani Z., Zardoune M., Karib H., Bengoumi M., 2002.** Camel meat quality. Advance course : Improvement of camel production. CIHEAM-IAV Hassan II, Rabat, (Morocco), 45 pp.

[27] **Holtenius K., Agenäs S., Delavaud C., Chilliard Y., 2003.** Effects of feeding intensity during the dry period. 2. Metabolic and hormonal responses. J. Dairy Sci., 86, 883-891.

[28] **Liefers S.C., Veerkamp R.F., Te Pas M.F.W., Delavaud C., Chilliard Y., Van der Lende T., 2003.** Leptin levels in relation to energy balance, milk yield, dry matter intake, live weight, and fertility in dairy cows. J. Dairy Sci., 86, 798-807.

[29] **Meikle A., Kulcsar M., Chilliard Y., Febel H., Delavaud C., Cavestany D., Chilibroste P., 2004.** Effects of Parity and Body Condition Score at Calving on Endocrine and Reproductive Parameters of the Dairy Cow under Grazing Conditions. Reproduction, in press.

[30] **Pond CM., 1984.** Physiological and ecological importance of energy storage in the evolution of lactation: evidence for a common pattern of anatomical organization of adipose tissue in mammals. Symp. Zool. Soc. Lond., 51, 1-32.
[31] **Prat M.L., 1993.** L'alimentation du dromadaire. Veterinary Doctorate Thesis, Ecole Nationale Vétérinaire, Maisons-Alfort (France), 125 pp.
[32] **Reist M., Erdin D., Von Euw D., Tschuemperlin K., Leuenberger H., Delavaud C., Chilliard Y., Hammon H.M., Kuenzi N., Blum J.W., 2003.** Concentrate feeding strategy in lactating dairy cows: metabolic and endocrine changes with emphasis on leptin. J. Dairy Sci., 86, 1690-1706.
[33] **Robelin J., 1981.** Cellularity of bovine adipose tissues: developmental changes from 15 to 65 percent mature weight. J. Lipid. Res., 22, 452-457.
[34] **Robelin J., Agabriel J., 1986.** Estimation de l'état d'engraissement des bovins vivants à de la taille des cellules adipeuses. Bull. Tech. CRVZ Theix, I.N.R.A., 66, 34-41.
[35] **Robelin J., Chilliard Y., Agabriel J., 1989.** Estimation of body lipids and proteins of Holstein Charolaise and Limousine cows by dilution technique and adipose cell size. In: Y. Van der Honing and W.H. Close (Editors), Proceedings of the 11. Symposium Energy Metabolism of Farm Animals. EAAP Publication, Pudoc, Wageningen, 43, 370-373.
[36] **Robelin G., Casteilla L., 1990.** Différenciation, croissance et développement du tissu adipeux. INRA Prod. Anim., 3, 243-252.
[37] **Sebastian I., Chilliard Y., Jaime C., Purroy A., 1989.** Variations du volume des adipocytes et de la note d'état corporel chez la brebis Rasa Aragonesa pendant la lactation et après le tarissement. Ann. Zootech., 38, 83-90.
[38] **Sebastian-Porroche I., Chilliard Y., Purroy A., Jaime C., 1993.** Supplémentation en céréales, état corporel et enzymes lipogéniques du tissu adipeux chez la brebis Aragonesa. Ann. Zootech., 42, 299-313.
[39] **Smith S.B., Prior R.L., Koong L.J., Mersmann H.J., 1992.** Nitrogen and lipid metabolism in heifers fed at increasing levels of intake. J. Anim. Sci., 70, 152-160.
[40] **Tibary A., Anouassi A., 1997.** Theriogenology in camelidae. Anatomy, physiology, pathology and artificial breeding. Actes Editions Publ., Rabat, (Maroc), 489 pp.
[41] **Wilson R. T., 1989.** Ecophysiology of the camelidae and desert ruminants. Springer Verlag, (Berlin), 120 pp.
[42] **Yagil R., 1985.** The desert camel: comparative physiological adaptation. Comparative animal nutrition. (Ed.), Karger, (Basel), 163 pp.

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Standards for Camel Milk

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Abstract. As other dairy products, camel milk and its products must comply with national and international quality and safety standards. Standards are basically divided into microbiological and physico-chemical ones. There are yet no major proven differences between camel milk dairy products and those of any other dairy animal, thus the level of bacterial cleanliness and product safety applied for camel milk could not be lowered or disregarded.

The role of such proposed standards will be the assurance that standardized camel milk will not pose any health risk to the consumer. Pasteurization is the accepted technology to achieve this aim, and the assurance of a proper heat treatment is an inevitable step in establishing pasteurization schedule for camel milk. Nevertheless, pasteurization may not eradicate all pathogens. Therefore, it is mandatory to study, identify and monitor the bacteriological flora of incoming raw milk and post-pasteurization milk. Finally, it is important to provide the authorities with suitable tools to assure that milk was properly pasteurized. Acceptable physico-chemical standards to ascertain proper pasteurization must be developed. Alkaline phosphatase test (AP) is the acceptable mean to assure proper pasteurization for bovine milk. However, it seems that camel milk AP is heat stable and can not fulfill the role of an indicator. Other means to assure proper pasteurization of camel milk are being studied such as tests based on the inactivation of γ-glutamyltransferase (GGT) and lactate dehydrogenase (LDH).

A following step would be the establishment of product identity and purity. This should include major milk constituents: water, fat, protein, lactose and minerals, as well as specific camel milk biochemicals. Steps towards achieving this goal have already started in various countries around the world.

1. Background

Similarly to other dairy products, camel milk and camel milk products must comply with quality and safety standards if it is intended for trade. Standards are basically divided into microbiological and physico-chemical ones. Most milk standards are based on the well known standards for bovine milk. There are some known differences between the composition of bovine and camel milk [6]. Yet, these differences do not indicate that the level of bacterial cleanliness and product safety applied for camel milk could be lowered or disregarded.

The primary role of any proposed standards for camel milk should be the assurance that the milk will not pose any health risk to the consumer. The secondary role will be the assurance that there is an agreement between producers and consumers on the composition of camel milk and its nutritional value [11].

Table 1. Somatic cell counts and *NAGase* activity in camel milk and other dairy animals (milk sampled on the glandular level, i.e., half or quarter udder).

	SCC		*NAGase*	
	Uninfected	Infected	Uninfected	Infected
Camel	118,000	308,000*	96	89
Cow	100,000	>1,000,000	18	60
Sheep	374,000	3,272,000	38	77
Goat	485,000	2,203,000	-	-

* Conditional number, work in progress.

2. Factors Affecting the Standards of Camel Milk

The base of production and the source of all quality parameters is the camel herd. Managing the herd, especially milking, will affect all the properties of the milk. At present, there is no commercial production of milking machines for camels. The nature of the she-camel which releases milk only when the calf is present [13], makes the design and production of milking machine more complicated. Efforts have been made in various countries, especially in the former Soviet Union republics, to adapt milk liners of different configurations for such a machine with no commercial success. Therefore there is no mechanical milking of camels, which affects the quality of camel milk and is a major obstacle for the industrialization of camel milk trade.

There are few industrial dairies that process camel milk; consequently there are at present no established or recommended biological/chemical standards of acceptance of raw camel milk. In order to establish such standards, the properties of camel milk should be studied. Somatic cell count (SCC) is an acceptable standard for raw bovine milk. "Good" camel milk was demonstrated not to exceed the acceptable levels for bovine milk; around 120000 cells/ml. However camel milk from infected glands in its subclinical form, showed counts of 300,000 cells/ml [5], lower than SCC generally reported for bovine milk coming from subclinical mastitic glands [2]. The search for an indication of intra-mammary infection led to the study of N-acetyl-β-D-glucosaminidase (*NAGase*) in camel milk [5]. In bovine milk there is a positive correlation between intramammary infection, SCC and *NAGase*. It was found that in camel milk the *NAGase* level of uninfected glands is 5 times higher than that of uninfected glands of bovine, therefore presently, *NAGase* activity cannot be used as complimentary diagnostic tools for assessing the validity of bacterial finding of infected udders in camels (Table 1). More data must be collected in order to establish suitable measures of udder health in camels.

3. Enumeration of Bacteria in Milk

Bacterial enumeration in milk is presently the acceptable tool to assure milk quality and safety. Bacteriological standards devised for bovine milk are used at present in most countries. The enumeration of bacteria as quality standard of raw milk is used for all other dairy animals. The kinetics of thermal death of *E. coli* in camel milk was studied (Figure 1) and no significant difference between camel and bovine milk in this respect was observed [12]. Thus, this study should be continued. Our studies indicate that camel milk bacterial quality is often not up to the accepted standards of bovine milk (Table 2). These standards are: Pasteurized Milk Ordinance, PMO, (1999); Grade "A" raw milk; "Individual producer milk not

Table 2. Bacterial counts in raw camel milk (commingled milk).

Milk sample	Total bacteria CFU/mL	Coliforms CFU/mL
1	1.41×10^5	6.80×10^4
2	2.44×10^4	8.00×10^3
3	6.20×10^5	1.17×10^5
4	1.20×10^8	4.00×10^7
5	2.50×10^6	1.40×10^3
6	5.50×10^6	9.00×10^2
7	8.00×10^4	5.00×10^3
8	5.30×10^8	9.00×10^7
9	4.70×10^6	8.50×10^5

to exceed 100,000/ml (1×10^5) prior to commingling"; "Not to exceed 300,000/ml (3×10^5) as commingled milk prior to pasteurization".

4. Bacterial Identification

Bacteria growing in bovine milk were investigated for decades. These investigations revealed that bovine milk contains harmful and pathogenic bacteria, saprophytic bacteria and industrial useful microorganisems, i.e., probiotic bacteria. Their growth patterns, isolating media, sources and environmental interactions are relatively well known. This bacterial population is dynamic and is affected by many different variables. Most of these phenomena are unknown for camel milk. There is apparently little knowledge about the influence of the natural bacterial flora of camel milk, either on the camel itself or the consumer. There are some indications of the presence of pathogenic bacteria in camel milk (Brucella antibodies), but knowledge on the transfer of pathogens through camel milk is lacking.

5. Standard of Identity and Compositional Analyses

The composition of camel milk is important to the consumer from its nutritional point of view. Several studies have attended to this subject. It was found that camel milk composition varies to a greater extent between herds under different husbandry regimes than bovine milk [10]. Large variations in the composition of camel milk also occur during the lactation cycle [8]. These differences must be attended to by informing nutritionists and by standardization of the production system as was done with other milk producing animals.

6. Cleaning and Sanitizing at the Farm Level

Presently, camels are milked only by hand under extreme environmental conditions around the world, with a unique problem of the presence of dust. This adversely affects the cleanliness of milk, its microbial flora and the contents of other contaminants. The presence of the suckling calf poses numerous unfamiliar cleanliness risks of bacteriological and veterinary nature. Further more, the execratory system of the she-camel, which tends to contaminate the hind legs with its urine is different from that of bovine and may pose a sanitary problem. The introduction of milking machines will markedly improve this situation. Until then, special milking and cleaning schemes for camel milk must be devised.

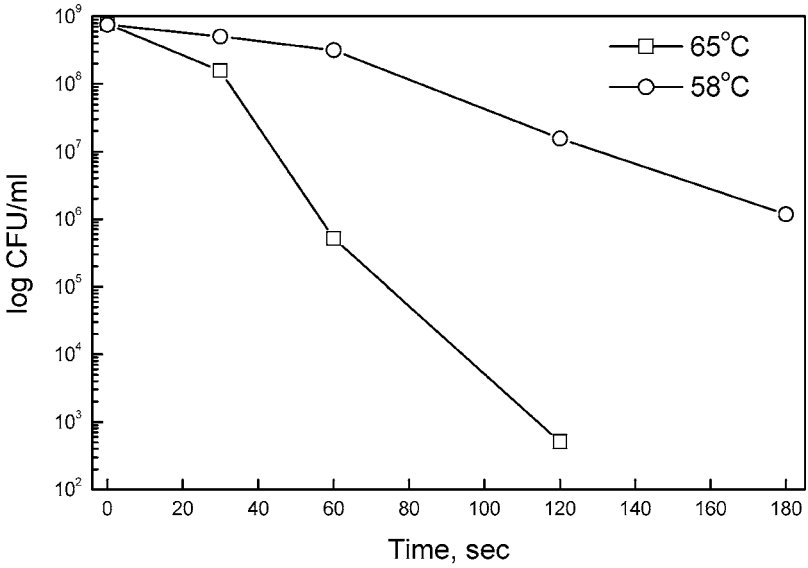

Figure 1. Thermal death of *E. coli* in camel milk at 65 and 58°C.

7. Technological Treatments of Camel Milk

Pasteurization is the accepted technology to assure the bacterial safety of milk. It is defined as heating milk to a certain temperature and holding it for a given length of time that ensures the killing of pathogenic bacteria that could be present in raw milk. The commercialization of camel milk is dependent on its proper pasteurization. A strict definition of a proper heat treatment is a mandatory step in establishing pasteurization scheme for camel milk. Pasteurization may not completely eradicate all pathogenic bacteria. Therefore, it is important to study, identify and monitor the bacteriological flora of incoming raw camel milk and of post-pasteurization camel milk. Finally, it is important to provide the authorities with suitable tools to assure that milk was properly pasteurized. The effectiveness of pasteurization of camel milk at close to low-temperature long-time (LTLT) pasteurization was studied by Sela *et al.* [12], as presented in Figure 1.

Supervising authorities demand a method to assure proper pasteurization. Already in 1935, Kay and Graham found that alkaline phosphatase could serve as an indicator of proper bovine milk pasteurization. There are studies that show that this enzyme is heat stable in camel milk and could not be used as an indicator for appropriate pasteurization. Therefore, other suitable pasteurization indicators for camel milk such as γ-glutamyltransferase (GGT), lactate dehydrogenase (LDH) or any other heat liable enzymes should be studied (http://camelides.cirad.fr/fr/liens/Doc/posterlait.ppt; Merin, unpublished results).

8. β-Lactoglobulin (β-lg)

The case of β-lg indicates what has been achieved in camel milk research and what is yet to be accomplished. Several researchers have demonstrated some differences between milk proteins profile of camel and other animals [3,6,7]. The apparent absence of β-lg in camel

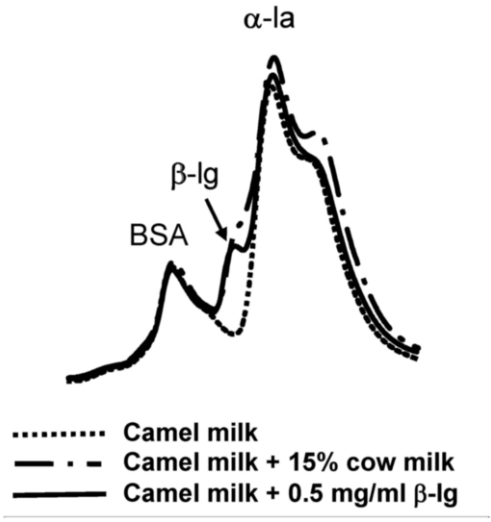

Figure 2. Size exclusion chromatograms of raw camel milk and camel milk adulterated with β-lactoglobulin and 15% cow milk.

milk was confirmed by Merin *et al.* [9]. Lately, the addition of milk containing β-lg to camel milk was demonstrated using this constituent as a marker. This finding might be used to ascertain the purity of camel milk (Figure 2).

At present the analytical methods for bovine milk composition are highly standardized according to accepted standards, i.e., ISO, IDF, etc. In addition, numerous commercial organizations are developing and selling computerized automatic instruments that assure milk composition at source and along the marketing channels. All these depend on the physico-chemical properties of the milk in question. Before all these extensive systems are applied to camel milk it should be assured that they are valid for this milk, i.e., the camel milk possess the tested physico-chemical properties and the test is not affected by the presence of milk constituents specific for camel. After all, camel is biologically different from other dairy ruminants.

9. Therapeutic Properties of Camel Milk

A major chance for successful camel milk trade lies in two fields, i.e., first, increasing subsistence base in developing countries that grow camels; second, commercializing the milk nutraceutic properties as was practiced in traditional and native medicine for many years and lately reported [4,1].

10. Manufacturing of Camel Milk

Most milk producing countries have established written standards for milk treating establishments. Such standards, for camel milk should be published, discussed and then implemented. These should include specifications for structures, machines, cleaning systems, packaging machines and packages. Not all manufacturing specifications for bovine milk that are used in industrialized countries can be presently applied in camel milk producing countries.

11. Retail

Modern retailing channels for milk that include well designed refrigerated chain, are not fully available to the camel milk industry. The number of modern dairies that sell camel milk products is sparse. Few dairies that manufacture camel milk have succeeded commercially. Before any major investment in the production-base (milking herds) of the camel milk industry is contemplated, there should be a parallel attention to standardized and supervised distribution channels.

References

[1] **Agarwal, R.P., Swami, S.C., Beniwal, R., Kochar, D.K., Sahani, M.S., Tuteja, F.C. and Ghorui, S.K.,** 2003. Effect of camel milk on glycemic control, lipid profile and diabetes quality of life in type 1 diabetes: A randomized prospective controlled cross over study. *Indian J. Anim. Sci*., 73:1105-1110.

[2] **Auldist, M.J. and Hubble, I.B.,** 1998. Effects of mastitis on raw milk and dairy products. *Aust. J. Dairy Technol*., 53:28-36.

[3] **Beg, O.U., Vonbahrlinstrom, H., Zaidi, Z.H. and Jornvall, H.,** 1987. Characterization of a heterogeneous camel milk whey non-casein protein. FEBS Lett. 216:270-274.

[4] **Breitling, L.,** 2002. Insulin and anti-diabetes activity of camel milk. *J. Camel Practice Res*., 9:43-45.

[5] **Chaffer, M., Leitner, G., Glickman, A., van Creveld, C., Winkler, M., Saran, A. and Yagil, R.,** 2000. Determination of udder health in camels (*Camelus dromedarius*). *J. Camel Practice Res*., 7:171-174.

[6] **Farah, Z.,** 1993. Composition and characteristics of camel milk. J. Dairy Res., 60:603-626.

[7] **Kappeler, S.R., Farah, Z. and Puhan, Z.,** 2003. 5'-flanking regions of camel milk genes are highly similar to homologue regions of other species and can be divided into two distinct groups. *J. Dairy Sci*., 86:498-508.

[8] **Merin, U., Bernstein, S., Bloch-Damti, A., Yagil, R. van Creveld, C., Lindner, P. and Gollop, N.,** 2001a. A comparative study of milk serum proteins in camel (*Camelus dromedarius*) and bovine colostrum. *Livestock Prod. Sci.,* 67:297-301.

[9] **Merin, U., Bernstein, S., van Creveld, C., Yagil, R. and Gollop, N.,** 2001b. Camel (*Camelus dromedarius*) colostrum and milk composition during the lactation. *Milchwissenschaft*, 56:70-74.

[10] **Merin, U., Rosen, B., Bernstein, S., Yagil, R. and Gollop, N.,** 1998. Effects of husbandry practices on the composition of Israeli camel milk. *Milchwissenschaft*, 53:680-682. Pasteurized Milk Ordinance (PMO), 1999. http://vm.cfsan.fda.gov/~ear/p-nci.html.

[11] **Sawaya, W.N., Khalil, J.K., Alshalhat, A. and Almohammad, H.,** 1984. Chemical-composition and nutritional quality of camel milk. *J. Food Sci*., 49:744-747.

[12] **Sela, S., Pinto. R., Merin, U. and Rosen, B.,** 2003. Thermal inactivation of *Escherichia coli* in camel milk. *J. Food Protect.,* 66:1708-1711.

[13] **Yagil, R., van Creveld, C., Abu-R'Kaik, G. and Merin, U.,** 1999. Milk "let-down" in camels. *J. Camel Practice Res*. 6:27-29.

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Modern Dairy Products from Traditional Camel Herding: An Experience in Mauritania

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Abstract. Camels and are increasingly viewed as an economic asset for arid lands. The first way to tap the economic potential of any animal resource is to use the milk. Easier said than done, when mobile low-density herds roam far from market centres. However, it is possible, and Tiviski's experience in Mauritania proves it. To sell significant quantities of dairy products the first requisite is a market, and therefore suitable packaging. If the target market is a modern city, modern packaging requires some form of microbe-reducing processing, e.g. heat treatment. Therefore a (small) modern dairy is the main link between camel herders and the market. The link between the dairy and the market is standard; but the real challenge is the link between the milk suppliers and the dairy, i.e. the collection of camel milk from scattered herders. In Mauritania free-ranging camels are milked by hand in the morning and the evening ; twice a day, regular and 4x4 pick-up trucks collect dozens of milk churns along varying routes on dirt-tracks and sandy paths and deliver them to collecting centres belonging to the dairy. Camel milk can be pasteurised following the same methods as cow milk, although products involving curdling, particularly cheese, call for special know-how. The best plant to process camel milk is a simple, inexpensive mini-dairy, which can break even at a low production level compared to conventional dairies. Camel milk cannot be sterilized, as it is destabilized by high temperatures. By following simple quality control procedures based on HACCP, Tiviski markets high-quality end products and provides an income for a large number of herders, giving camels renewed glamour as cash-earning livestock.

1. The Camel Economy

If, as someone said, animals "were designed by plants to move seeds around", camels received a particularly tough assignment: moving seeds around arid zones. The obvious fact that camels are well adapted to deserts, and that they are an economic resource in arid areas, is now increasingly accepted, and is in fact the reason underlying this conference.

The best way to protect and develop camels is to make them economically attractive, by enhancing their ability to be productive in places where other animals cannot even survive. The first and easiest revenue from livestock is provided by milk. This also applies to camels, with the added advantage that the revenue accrues to nomadic herders, who practice a useful way of life but who can be living in very harsh conditions compared to the sedentary population and may therefore tempted to give up and settle in towns.

However, camels do not make things easy:

– On one hand, because camels are specially adapted to arid areas where pasture is sparse, livestock density is low; besides, since camels have usually not been bred

for milking, and they walk long distances to browse, milk yield in roaming desert camels is low. As a result, the amount of collectable milk per square kilometre can be very small. Collecting milk from mobile suppliers may require somewhat unconventional means.

- On the other hand, to make an income from milk, it must be sold, which requires a market, i.e. a place where many people are concentrated within a small radius: towns. Unfortunately, most camels and their owners live far away from towns, and it is difficult to sell milk to neighbouring herders…
- If milk is to be taken to market, and to be kept for a few days until it is sold, it must be packaged safely. This in turn cannot be done properly unless milk undergoes some form of treatment to reduce microbial activity, e.g. pasteurisation.

Therefore, a processing plant is a suitable and convenient link between milk production and the market.

2. From Herd to Market

So, is it possible to link nomadic herders and the milk market? Yes! A private Mauritanian dairy has been making and marketing camel dairy products for 15 years.

This experience may be useful for other countries: it is based on very simple principles, and appears to be reproducible and adaptable to other environments. Certainly other Mauritanians are doing it, too.

3. Mauritania

Mauritania is a large country, located in North-West Africa, on the Southern border of the great Sahara desert. With a surface area of 1,034,000 sq. km, the population is estimated at only 2,700,000, illustrating the fact that most of the territory is uninhabited.

However, the e country does have great expanses of sparse scrubby vegetation, and fairly lush grassy savanna in the South-East, grazed by transhumant livestock estimated at about:

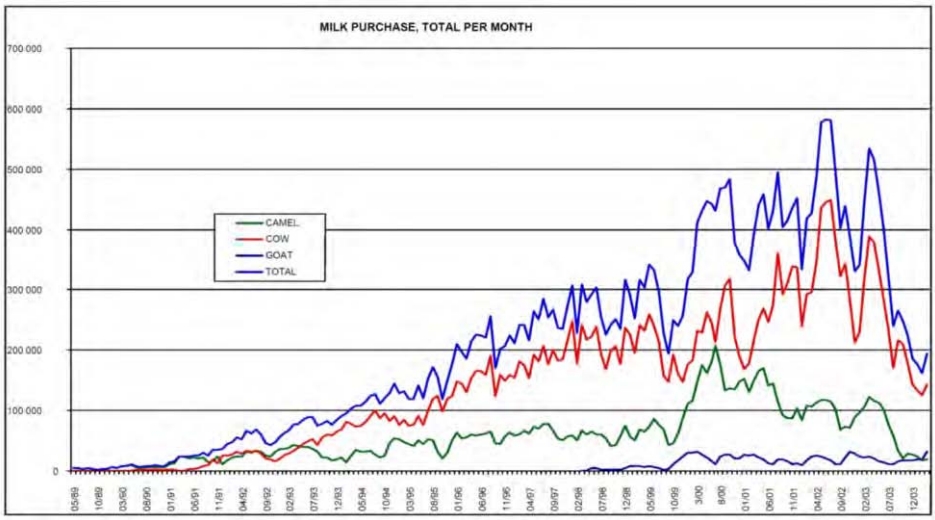
- 1,000,000 dromedary camels
- 1,500,000 cattle
- 10,000,000 sheep and goats.

4. Tiviski – the Enterprise

Tiviski is a privately-owned firm which has been operating since April 1989. At the outset it was a mini-dairy designed only to pasteurise 600 litres/hour camel milk (the only fresh milk available at the time around Nouakchott, where most of the country's consumers are concentrated) and package it in gable-top cartons. Capacity is now 2,450 litres/hour, (plus 1,800 litres/hour UHT production capacity), including more than 15 products.

After a very difficult beginning, Tiviski has grown from 6 employees and a dozen suppliers in 1989 to a staff of 230 and 1,000 suppliers in 2004, but development has not been smooth: seasonal supply and demand problems are a permanent problem, as the graph shows, leading to the production of camel cheese and UHT cow milk.

It is important to note that cow milk appeared in Nouakchott and was pasteurised in 1990. Owing to the fact that there are more cattle and people who drink cow milk than



camels and their clients in Mauritania, the dairy has grown more than it would have done with cow milk alone; at present cow milk is the main product in volume.

5. Getting Camel Milk to Market

Four main links must be considered in the chain between the camel herd and the milk consumer:

5.1. Producing Camel Milk

This is herders' business. Tiviski's original decision was not to produce milk, but rather to buy it from camel owners. This is perfectly commonplace in most countries, but not yet the rule in West Africa, where "experts" advise recombining milk powder, an option that undermines the local livestock sector.

Although the firm is not involved in camel breeding or milk production, Tiviski has set up a specialized organization designed to help herders improve milk quality and their own profitability, so as to keep milk price within reasonable control. This organization provides feed, veterinary care and medicine, vaccination, information and instruction on feed rations and milking hygiene.

It should be noted that Tiviski encountered major difficulties in getting herders to supply milk, on account of very deep-rooted traditional prejudice against selling milk. If this problem is encountered, it must not be underestimated. It takes many years to overcome the reluctance, and the people who overcome it first are not necessarily the most educated or the most likely to learn quickly about hygiene, economics and environment protection.

5.2. Collecting Camel Milk

Tiviski collects milk from about 1,000 herders, all more or less mobile in fairy large areas. Most of them raise cattle, some raise camels, some have both, and many supply goat milk.

The system developed in these conditions is based on three collecting centres in the better pastoral areas in the South of Mauritania: the centres are located in Rosso, Boghé and Kaédi, located 200, 320 and 420 km from the dairy. Kaédi is not active yet, for lack of milk since it was opened.

Tiviski buys and processes:

- Camel milk (20 to 40% of the total)
- Cow milk (50 to 75%)
- Goat milk (8 to 12%)

Quantities and proportions vary with seasons. The maximum collected so far was 20,000 litres/day, of which up to 7000 camel milk, but since 2002 a drought-induced lack of milk has reduced raw material supply to 7,000 litres/day.

Milk is bought directly from individual herders, but collected and carried from the herds to the centres by transporters, who in some cases are herders with a vehicle, and in two cases pick-up trucks rented by the dairy. These vehicles, which can be ordinary pick-up trucks, 4x4 pick-ups, donkey carts, taxis, vans, bicycles, etc., go the rounds of the camps, villages, settlements and mobile herds twice a day (at distances of up to 90 km), pick up the filled milk containers and take them – at ambient temperature – to the collection centres. Once the reception operations are completed, they return and distribute the empty churns along the way, and start all over again.

The only requirements are that milk be fresh, reasonably clean and undiluted. At the centres, the numbered churns (aluminium cans if possible, covered plastic bins otherwise, with a large neck for easy cleaning) are weighed, recorded, and tasted for freshness and watering. The milk is then poured through a filter into a chilling system and pumped to chilling tanks.

Buying the milk directly, avoiding intermediary independent collectors is essential in order to keep control over quality. Any container with milk that is dirty, or not fresh, or watered, can be returned to its owner. Herders learn the lesson quickly, and after years explaining all about cleanliness and speed, the microbiological quality of milk delivered is remarkable: the bulk plate count is usually below 500,000, measured on arrival to the laboratory in Nouakchott.

In the cool hours late at night, tanker trucks haul the chilled milk from the centres to the plant in Nouakchott.

All the purchase data are recorded and fed to computers, so that suppliers can be paid on request.

Custom-made software is the key to managing such a large number of suppliers. The system also keeps track of reimbursements for feed, veterinary medicine and care, vaccinations, aluminium churns, all supplied on credit.

5.3. Processing Camel Milk

Camel milk can be pasteurised the same way as cow milk, with good results, although phosphatase and peroxydase remain positive. Tiviski pasteurizes camel milk at 80°C. Research for a specific test to verify proper pasteurisation, instead of the inoperative phosphatase test, would be welcome. Mauritania has no legislation on the subject, so it has not faced any problems, but in countries with regulations applied to cow milk the sanitary authorities may have to be convinced to set up specific conditions for camel milk.

Camel milk does not curdle naturally, so it cannot readily be processed into all dairy products, e.g. yoghourt, which does not make a firm enough gel.

Cheese can be made from camel milk, although the yield is poor and the process quite tricky. In hot, dry desert climates, it requires chilling and humidifying - expensive!

Tiviski's pasteurising plant is fitted with state-of-the-art, stainless steel, small scale equipment: plate heat exchangers, automatic carton fillers, etc.

The only products made from camel milk are:

- Fresh pasteurised camel milk in 0.5-litre gable-top cartons,
- Fresh pasteurised blend of camel (65%) and cow (35%) milk in 0.5-litre gable-top cartons,
- Cheese made from camel milk,
- Cultured camel milk was made, but discontinued.

Camel milk cannot yet be processed by the UHT technology, owing to its instability at very high temperatures.

Drying camel milk seems to be the ideal solution for long-term preservation, particularly in a country with cheap energy, but Tiviski does not have the equipment to carry out tests.

5.4. Marketing Camel Milk

The last link in the commercial chain, but not least.

Marketing camel milk is no different from marketing other dairy products. of course, the type of products offered depends on local consumer preference: fresh milk, chel, shubat, airan, cheese…

In situations where milk is distributed to many small shops, the cold chain may be difficult to comply with. Tiviski delivers every day or every other day to over 2,600 retail shops, by means of a dozen small heat-insulated delivery vans, each with a driver and a salesman, that shuttle back and forth from the dairy so that the products do not remain too long out of cold storage. Shops all have refrigerators, but when the weather gets very hot the milk's shelf life is shortened dramatically.

Although there is a popular myth about camel milk 'never going off', experience shows that pasteurised packaged camel milk does not keep any better than its cow equivalent, and seems to lose its flavour faster. However, Tiviski's products keep for two weeks in continuous cold storage, and hold up for the one-week "best-by" date in shop refrigerators. Careful attention must be given to packaging choice and design.

It is sometimes tempting to advise low-cost low-tech packaging for less developed countries, but in a globalized world it may not compete well. Even poor consumers prefer glamorous products.

Therefore, when designing dairy products, a (sometimes difficult) choice must be made between:

- Plastic sachets
- Cartons
- Plastic bottles
- Glass bottles.

Each type of packaging presents a number of assets and drawbacks, and a lot depends on local custom and culture. There is no ideal solution. To give some examples of the considerations involved:

- In Mauritania, milk is a 'social' drink, and sachets just do not sell as well as cartons. Some countries have great results with sachets. If so, it is the ideal solution: cheap, small waste volume, made on relatively cheap equipment.
- Glass bottles are inert and re-usable: wonderful if they can be made locally, but importing them from afar is not an option; besides, they have to be retrieved and washed, which is expensive. They also have the drawback of letting light through.

- Plastic bottles have good consumer appeal and a relatively low price, but unless efficient garbage collection and disposal is available they can be a threat to the environment. Besides, plastic bottles raise the investment bill, as bottle-making equipment must be included.
- Cartons are attractive, practical, environment-friendly, recycled by goats, they provide a great printing surface, but they are relatively expensive.

Conclusion

May some hints be offered as a conclusion?

- Income can be effectively generated from camel milk through de-centralized, community-level, small-scale processing.
- Once herders are making money from milk sales, they will look after (and pay for) the rest: feeding, veterinary care, genetic improvement, etc. provided suitable services are made available. It is important to provide instruction on feed calculation, as herders may not have the required know-how in their traditional knowledge base.
- The key to success is an efficient and flexible collecting system designed to retrieve milk from mobile herds twice a day.
- Small-scale hi-tech equipment is a key to high-quality products.
- It is very important to strive for high product quality. Not only do customers prefer good products, but products with fewer germs have a longer shelf life and entail fewer losses. Selling perishable products means retailing them directly, or else warranting take-back if products are not sold. This can be extremely costly if products do not keep well.
- Dairy products in attractive packaging sell better.

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Lactoferrin of Camel Milk of Kazakhstan

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Abstract. Lactoferrin is iron containing protein with molecular mass 76-80 kDa with 689 amino acids residues and two Fe^{3+} binding centres. This relatively recently known protein has a number of properties. These are anti-bactericide activity, antiviral, anti-fungal, anti-carcinogenic, anti-inflammatory activity, antioxidant and analgesic properties. Lactoferrin raises immune response of organism and is involved in Parkinson's and Alzheimer's diseases. Lactoferrin is presented in all excretory secrets of mammals such as tear secrets, saliva, blood, urea, nasal and uterus cavity, sperm and amniotic and also in neutrophil of leucocytes. But mostly lactoferrin is presented in milk and colostrum.

Comparative survey of lactoferrin concentration in different milks showed that biggest content of lactoferrin is in camel milk. Camel milk has 30-100 times higher concentrations of lactoferrin than bovine milk. After heat treatment at 85°C camel milk still contains 37% of lactoferrin while bovine milk only 1,2%. Bovine and camel lactoferrin are homological with affinity in amount of 74,9%. Amino acid compound studies showed that camel lactoferrin is rich with *Met* while bovine lactoferrin is rich with *Val*.

Camel milk is traditional food product for Kazakhstan and is accounted to be health-giving product helping to heal and to prevent many diseases. But these properties of camel milk are still not proved by scientists. We believe that lactoferrin is remarkably responsible on such properties of camel milk.

Lactoferrin used as preserving agent in food, medicines and cosmetics. Technologies of industrial purification are now developing. The number of use targets is rapidly growing. For example lactoferrin can be used in diagnostics of inflammation processes.

Introduction

In Central Asia, camel milk is known for its medicinal properties. It is used for many health disorders in human organism. These properties could be attributed to the biochemical composition of the camel milk which has specific protein components both in quality and quantity. Lactoferrin (LF) is one of the most important polypeptide among milk protein which represents a health factor for milk consumers. Lactoferrin is iron containing protein with molecular mass 76-80 kDa having 689 amino acids residues and two Fe^{3+} binding centres. It shows a wide type of activities described in different species. The present study deals with the biological properties of lactoferrin after a description of the characteristics and quantity of camel lactoferrin (cLF) compared to other species.

Table 1. Concentration interval of LF in some mammal milk at different lactation stage (in mg / mL).

	Camel	*Mare*	*Cow*	*Goat*	*Ewe*	*Sow*	*Mice*	*Rabbit*	*Dog*
LF	*2-6*	*0.2-2.0*	*0.02-0.2*	*0.02-0.2*	*0.02-0.2*	*0.2-2.0*	*<0,05*	*<0,05*	*<0,05*

Table 2. Concentration in total proteins (**TP, %**) and lactoferrin (**LF, mg/mL**) in milk and colostrum from different animal species (*El-Gawad et al., 1996*) [26].

	Camel		**Cow**		**Goat**		**Ewe**		**Buffalo**	
	LF	TP	LF	TP	LF	TP	LF	TP	LF	TP
Colostrum*	5.10	8.26	0.84	12.68	3.09	9.50	1.56	18.89	2.1	14.57
Milk**	2.48	2.79	0.08	4.00	0.17	3.50	0.14	6.26	0.05	4.10

*0–2 days after beginning of lactation ; **15-30 days after beginning of lactation;

1. Medicinal Properties of Camel Milk

The abundance of LF in camel milk, associated to other proteins with antibacterial activities, could explain a part of the medicinal virtues of this product which is commonly used as a cure in the treatment of some infectious diseases [22,17]. In Central Asia, the use of camel milk to treat human tuberculosis in sanatorium is old [53]: with 2 litres per day for 2 to 4 months, the authors said to get a marked improvement of the patients and a significant recovery of blood parameters. Those results are confirmed in India on TB patients drinking one litre per day [40] and in Libya with a cure of 1.5 litres/day with visible effect from the first weeks of the cure [3]. Fermented milk (at Kazakhstan called *shubat*) is rich of lactic bacteria, which reinforce antimicrobial properties contra pathogen germ, like *Bacillus, Pseudomonas, Mycobacterium, Staphylococcus, Salmonella et Escherichi* [46]. But their properties is moor large than only effect antimicrobial due with proteins. Some auteur associate therapeutic quality of camel milk with composition of trace elements like copper, manganese and molybdenum [41] moreover it have not difference with another milk species of mineral composition [18]. In addition camel milk is associated also with exception richest of vitamin C, which liaison with immunity system of general ruminants and particularly dromedary [27]. Furthermore, some auteur advance benefice effect on some metabolic and nutritional diseases, on the first place is debate. Regular consummation of camel milk has hypoglycemiant action and regulator of glycaemia of insulin dependant patients [1]. Meanwhile, numbers of experimental protocols which rest upon their assertions stay disputable. It is fortunately probably that camel milk has benefice action on the health, but research has to be more deepened [55].

2. Camel LF: Quantity and Characteristics Compared to other Species

The quantity of LF in milk has been determined by different methods in the published studies. So, the comparison between the values of LF is quite difficult. In the present study, the published values could be compared within table only, not between tables.

Compared to milk from other species, camel milk seems to be the richest in LF, except human colostrum. According to Mason and Heremans [42] and Qian [47], the observed concentration in camel milk is on average 10 to 100 higher than in cow milk (Table 1).

As for the most of metalloproteins, the LF concentration decreases all along the lactation, maximum being observed in colostrum (Table 2).

Table 3. Physico-chemical characteristics of camel and bovine LF.

	Camel	**Cow**
Amino-acid residues	689	689
Molecular mass (kDa) by mass spectrometry	80.16 – 80.73	84.0
Molecular mass (kDa) by amino-acid sequence	75.250	76.143
Isoelectric point	8.14	8.18
Milk concentration (mg/l)	220	140
Homology %	74.9%	

Table 4. Amino-acid composition of lactoferrin in different species, residues/100g lactoferrin fraction (*Mahfouz et al., 1997*) [39].

Amino-acid	**Camel**	**Cow**	**Ewe**	**Goat**	**Buffalo**
Asx	0.07	0.07	0.06	0.06	0.08
*Thr**	0.04	0.05	0.02	0.04	0.04
Ser	0.03	0.03	0.03	0.03	0.02
Glx	0.11	0.11	0.09	0.11	0.10
Pro	0.03	0.05	0.10	0.02	0.06
Gly	0.05	0.06	0.03	0.04	0.03
Ala	0.07	0.06	0.07	0.07	0.04
Cys	0.02	-	0.01	0.01	0.02
*Met**	0.07	0.01	0.02	0.06	0.02
*Val**	0.02	0.06	0.07	0.02	0.03
*Ile**	0.04	0.03	0.02	0.04	0.03
*Leu**	0.10	0.09	0.08	0.09	0.06
Tyr	0.03	0.03	0.03	0.03	0.01
*Phe**	0.02	0.03	0.01	0.02	0.01
*Lys**	0.04	0.06	0.07	0.07	0.12
*His**	0.01	-	-	0.01	0.01
Arg	0.09	0.07	0.05	0.07	0.04

Table 5. Compared effect of heat treatment on LF of camel, cow and buffalo milk.

Temperature (°C)	**Camel**	**Cow**	**Buffalo**
	LF (mg/mL)	*LF (mg/mL)*	*LF (mg/mL)*
0	0.170	0.0767	0.0317
65	0.156	0.0570	0.0287
75	0.115	0.0200	0.0113
85	0.063	0.0009	0.0000
100	0.000	0.0000	0.0000

According to physico-chemical properties, camel and bovine LF have similarity at 74.9% (Table 3) [34].

The amino-acid composition of LF has been determined in different types of milk at different lactation stage, but comparisons are difficult because the units to express results and methods could be widely different (Table 4) [39].

As for much camel milk protein, LF in camel milk has specific physical properties. Especially, cLF is more thermo-resistant than for other species (Table 5) and more thermo-resistant than camel milk IgG . For example, at 85°C for 10 minutes, quantity of LF in camel milk is 37% of the initial value *vs* 1.17% only of LF in cow milk and 0 in buffalo milk in the same conditions [24].

Table 6. Carbohydrates composition (g /100 g) in different lactoferrins.

Carbohydrates	Camel		Cow		Buffalo		Ewe		Goat	
	*C	**N	C	N	C	N	C	N	C	N
Sialique acid	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
N, acetylglucose amin	3.35	2.51	1.39	3.07	1.67	1.95	1.67	1.67	1.95	1.39
Mannose	2.25	2.48	2.03	3.38	2.93	2.25	2.70	1.58	2.48	3.15
Fucose	0.21	0.21			0.20	0.21	0.21	0.21	0.21	0.21

*C – colostrum, **N –normal milk.

The carbohydrates composition of LF changes according to species. The LF in camel colostrum is particularly rich in N-acetylglucosamin (Table 6) [39].

The main characteristic of camel milk is its richness in LF and its thermo-resistance of this protein. Those two characteristics contribute to the health benefit of camel milk. Indeed, LF shows wide biological properties that are reported below.

3. Biological Properties of Lactoferrin

The biological activity of LF depends on the iron capacity of molecule. The biological activity of iron-unsaturated LF is similar to those of saturated LF, but with a lower efficiency. The main biological activities could be reported as follows:

- anti-bacterial activity,
- anti-virus activity,
- anti-fungal activity,
- activation of immune response,
- anti-carcinogen activity,
- anti-inflammatory activity,
- analgesic activity,
- anti-oxidant activity.

3.1. Anti-Bacterial Activity

LF has not bactericide effect on bacteria with low iron requirement. For example, *E.coli* needs high iron quantity, whereas *Streptococcus lactis* need very few. So, it explains that *E.coli* is inhibited by LF while *St.lactis* is not. However, the anti-bacterial activity of LF has been proved many times *in vitro*, but has never been demonstrated in irrefutable way *in vivo*. Moreover, some scientists consider that the explanation of bacterial growth inhibition by iron binding only is not satisfying. *et* Bacteriostatic activity of LF has been demonstrated in human mucus, in bovine colostrum and teat secretion out of lactation [38].

According to Elass-Rochard *et al.* [25] human and bovine LF have two capture sites for lipopolysaccharide (LPS) of *Escherichia coli*. Affinity of LF for LPS contributes to the inhibition of bacterial endotoxins.

The LF in tears plays a synergic role with antibiotics (vancomycin) inhibiting growth of *Staphylococcus epidermidis*, main pathogen agent in ophthalmic infections. Indeed, the presence of LF folds into the inhibiting activity of antibiotic [36].

According to Ellison [29] LF protein has synergic action with immunoglobins, the complement and cationic protein in neutrophiles against gram-negatives bacteria. In the protein, it is N-terminal peptide of LF which fragments the external membrane of Gram-negative bacteria.

Rabbit leucocytes have an anti-bacterial power of, notably the ability to phagocyte bacteria *Pseudomonas aeruginosa* because those cells contained a high quantity of LF [11].

Zagulki *et al.* [57] studied the interaction between *E.coli* and bovine and human LF. Some experiments were achieved to demonstrate and partially explain the protective effect of bovine LF after intravenous injection in mice 24 hours before one mortal dose injection of *Escherichia coli.* Around 70% of before hand treated mice with LF survived after injection. The survival rate in non treated mice and preliminary treated one with bovine serum albumin (BSA) were 4 and 8% respectively. Human LF has almost similar protective effect than bovine LF.

The antibacterial activities of LF were showed in compound contained penicillin G and bovine LF. Indeed, this compound increases 2 to 4 times the inhibiting activity of penicillin on *Staphylococcus aureus* growth. Inhibiting activity of LF, used alone, is from 16 to 64 more active than penicillin activity [20].

Singh *et al.* [50] showed that LF stopped the development of biofilms of pathogen opportunistic agents as *Pseudomonas aeruginosa.* This has been observed with low LF concentrations, lower to those destroying or preventing the growth of bacterias. By chelating iron, LF stimulates the external motility, leading the bacterias to wander on the surface in spite of to make fasces and cell biofilms.

On the other hand, LF or transferrin fragmentation by bacterial enzymes (notably elastase secreted by *Pseudomonas aeruginosa*) contributes to the iron binding by a bacteria siderophore (pyoverdin ou pyochelin) with cytotoxic properties [54]. *In vivo*, the elements of LF fragmentation were found in the washing products from upper respiratory way in patients affected by cystic fibrosis of lungs [9].

3.2. Anti-Virus Activity

LF is able to bind some antigens of virus nature. The main mechanism of LF anti-viral activity depends on LF binding with glucosamineglycans of eucaryotic membranes. The complex LF-glucosamineglycans plays protective role by stopping the virus penetration. This mechanism is observed in case of infection with cytomegalovirus responsible of herpes and with human immunodeficient virus (VIH) [38].

The mechanisms of anti-hantavirale activity of bovine LF were studied by Murphy *et al.* [43]. The LF combined to pre- and post-infection treatment by ribavirine has fully stopped formation of virus lesions. These results suggest that LF could constraint virus adsorption by the cells. Other studies testify the efficiency of LF in clinical uses as curative protector against hantavirus. To control the human infection due to hantavirus, LF associated to ribavirin is more employed combination for therapy.

Niehaus *et al.* [44] have used the rate of LF in nasal secretions to differentiate cold in head from more acute sinusitis. The LF is found in all secretions where the membranes bath. In mucus, LF is the first defence line against virus and other pathogen agents. So the highest values of LF are normally found in nasal secretions of patients affected with severe sinusitis. It is possible to distinguish sinusitis from cold in the head by comparing the LF concentrations in nasal discharge.

3.3. Anti-Fungal Activity

Anderson *et al.* [4] showed that LF is the milk protein which constraint the growth of dangerous mycetes. The human milk is known for its anti microbial properties and it has been proved in many occasions that babies fed at breast show a better resistance to infections than artificial milked babies. If many studies involved anti-bacterial and anti-virus activities, the anti-fungal effect was rarely achieved. The skin infections caused by mycetes are

common in babies affected by low growth. The powerful inhibiting factor on fungal growth was demonstrated *in vitro* (**a** : http://www.lef.org).

3.4. Immune Answer Activation

Dhennin-Duthille *et al.* [19] showed that LF is implicated in the lymphocytes CD4 regulation, essential to control disease. It is known that LF is directly linked to immune response but studies in this way have to be deepened to understand the linking mechanisms LF and immune system (**a** : http://www.lef.org).

3.5. Anti-Inflammatory Activity

Chissov et Yakubovskaya [13] have proposed an ointment containing LF as active principle against rhumatoïd arthritis. LF modulates the inflammatory process, more especially by early stimulating the excretion of cytokines from monocytes, and by regulating the proliferation and differentiation of immunized cells. Some of those activities are explained by the affinity of LF for some lipopolysaccharides (LPS) present at the surface of monocytes. All together, those observations strongly suggested that LF is one of the main molecules able to modulate the inflammatory response [5].

Fillebeen *et al.* [30] studied the LF carrying through the hematomeninge barrier in inflammatory conditions. The LF carried by activated capillary endothelial cells in bovine brain was increased. The LF was recovered undamaged on the abluminal side of the cells, suggesting that increased accumulation of LF could occur in physiopathological conditions.

3.6. Analgesic Activity

The 'Nuclear Receptor Ligand' society is developing medicament on LF basis. This team working at Kawasaki (Japan) in partnership with Agennix Inc. (Texas) is beginning clinical trials on treatment against pain. Some trials conducted by this company and Tottori University (Southern Japan) on rats have shown that LF was an efficient analgesic, with a similar efficiency as morphine in local application, the LF being degraded in the stomach. This company wanted to develop the use of LF in a medicament for parondopathy and hope to cooperate with agro-food industries (**b** : www.biotechnica.asso.fr/uplood/biotechnica/bv006.pdf).

3.7. Anti-Oxidative Activity

The anti-oxidative activities of LF depend on its ability to bind ferrous ions [32]. The anti-oxidative activity of LF is strongly higher than compounds used generally in pharmacy (Table 7) [13].

Belizi *et al.* [6] showed that LF inhibited free radicals more effectively than histidin and mannitol. When LF of human milk was added at suspension of eggs lipoprotein yolk with rodamin G intensity of Fe2+ induction of chemiluminescent was 37% lower. At 100% of iron saturation their antioxidant properties decrease 15,4% and intensity of chemiluminescent was decrease 25,7% compared to control. Also, Belizi *et al.* [7] observed that compound of LF from human milk during egg incubation in a physiological-like model shows spontaneous desamination.

3.8. Anti-Carcinogenic Activity

Chissov *et al.* [13,14] prepared a product on LF basis to use in oropharyngal zone after a chemotherapy. The LF is able to contribute in proliferation process and cellular differentia-

Table 7. Antioxidant activity of different compound used in pharmacy.

Compound	Activity ($mMol^{-1}$)
Lactoferrin	400
Dimethylsufoxyde	2.5
β-caroten	1.7
Ascorbique Acid	1.3
α-tocophérol acetate	0.1
retinol acétate	0.03

tion. Its has been identified also as a « *Colony Inhibitory* », by acting at the cell level in spinal marrow during the myélopoïèse [38]. Treated cells with LF showed a definitive stop of their functions, including the stop of metabolic activity of DNA and RNA precursors.

All these activities of LF, important protein of camel milk could contribute to the medicinal virtue of camel milk. Those have been studied in different countries.

Conclusion

Number of works deals with isolation of human or bovine LF, but very rare of camel LF yet. Most of them are references of liquid chromatography technique: affinity, exchange of ions, by molecular weight, immuno-affinity.

For affinity chromatography use heparin which had been scratched on stationary phase (gel) for its affinity at LF [8,2,31,12,16]. Often for isolation and purification of LF use different types of Sephadex for ion exchange chromatography and by molecular weight [28,10,56,21,48,49,47,26,23,15,51,45].

LF can be isolated by support of immuno-affinity with fixed monoclonal antibody [35,37,52]. All these methods are closed and give sufficient results with efficiency of extraction around 90%, but heavy to set up. On the other hand, they can be used to valid methods, which we are trying to develop in order to assess more precisely the variation factors of the quantities determined in camel milk in function of different criteria, like season, feeding, lactation stage and rank.

References

[1] **Agarwal R.P., Swami S.C., Beniwal R., Kochar D.K., Sahani M.S., Tuteja F.C., Ghouri S.K. (2003).** Effect of camel milk on glycemic control, risk factors and diabetes quality of life in type-1 diabetes: a randomised prospective controlled study. J. Camel Res. Pract., 10, 45-50.

[2] **Al-Mashikhi S.A., Nakai S. (1987).** Isolation of bovine immunoglobulins and lactoferrin from whey proteins by gel filtration techniques. J. of Dairy Sci., 70: 2486-2492.

[3] **Alwan A.A., Tarhuni A.H. (2000).** The effect of camel milk on mycobacterium tuberculosis in man. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100.

[4] **Anderson Y., Lindquist S., Largerqvist C., Hernell O. (2000).** Early Hum Dev. Aug ; 59 (2): 95-105.

[5] **Baveye E., Elass E., Mazurier J., Spik G., Legrand D. (1999).** Lactoferrin: a multifunctional glycoprotein involved in the modulation of the inflammatory process. Clinical chemistry and laboratory medicine. 37: (3) 281-286 mar.

[6] **Belizi S., Nazarova I.A., Klimova I.A., Prokofyev V.N., Pushkina N.V. (1999).** Antioxidant properties of lactoferrin from human milk. Bull. exper. biology and medicines 1999, 127, 5.

[7] **Belizi S., Nazarova I.A., Prokofyev V.N., Sorokina I.A., Pushkina N.V., Lukash A.I. (2001).** Changes of antioxidant properties of lactoferrin from human milk during dezamidation. Biochemistry, 66, 5, 712-717.

[8] **Bläckberg L., Hernell O. (1980).** Isolation of lactoferrin from human whey by a single chromatographic step. Febs Letters, V. 109, No 2, January.

[9] **Britigan B.E., Hayek M.B., Doebbeling B.N., Fick R.B.Jr. (1993).** Transferrin and lactoferrin undergo proteolytic cleavage in the Pseudomonas aeruginosa – infected lungs of patients with cystic fibrosis. Infect. Immun. Dec.; 61 (12):5049-5055.

[10] **Buchta R. (1991).** Ovine lactoferrin: isolation from colostrums and characterization. J. Dairy Res., 58, 211 – 218. Printed in Great Britain.

[11] **Bullen J.J., Armstrong J.A. (1979).** The role of lactoferrin in the bactericidal function of polymorphonuclear leucocytes. Immunology. Apr; 36(4):781-91.

[12] **Chen J.-P., Wang C.-H. (1991).** Microfiltration affinity purification of lactoferrin and immunoglobulin G from cheese whey. Journal of Food Science, 56, No 3, 701-706.

[13] **Chissov V.I., Borisov V.I., Yakubovskaya R.I., Boiko A.V., Nemcova E.R., Demidova L.V., Sergeeva T.V. Teleus T.A. (1994).** Médicament pour le traitement anti-tumeur dans la zone orophrigeale local et mode de soin dans cette zone. Препарат для лечения местных осложнений консервативного противоопухолевого лечения в орофарингеальной зоне и способ лечения в орофрингеальной зоне. Brevet° RU 2099065. (en russe).

[14] **Chissov V.I., Yakubovskaya R.I. (1995).** Médicament pour soigner la reumatoïde arthride. Препарат для лечения ревматоидных артритов. Brevet° RU 2088238. (en russe).

[15] **Chiu C.K., Etzel M. (1997).** Fractionation of lactoferoxidase and lactoferrin from bovine whey using a cation exchange membrane. Journal of Food Sciences, 62, No 5, 996-1000.

[16] **Chu M., Wang S.-R., Wenig C.-N., Pursel V.G. (1993).** Isolation and characterization of porcine milk lactoferrin. Am. J. Vet. Res., Vol.54, No. 7, July.

[17] **Chuvakova Z.K., Beisembayeva R.U., Puzyrevskaya O.M., Saubenova M.G., Shamenova M.G., Glebova T.I., Popova E.I., Baizhomartova M.M., Baimenov E.K. (2000).** Chemical composition, microbial control and antiviral properties of freshly made and conserved shubat "bota". Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 97-98.

[18] **Dell'Orto V., Cattaneo D., Bretta E., Baldi A., Savoini G. (2000).** Effects of trace element supplementation on milk yield and composition in camels. Int. dairy J., 10, 873-879.

[19] **Dhennin-Duthille I., Masson M., Damien E., Fillebeen C., Spik G., Mazurier J (2000).** Journal of cellular biochemistry, v.79, Issue 4, 583-593.

[20] **Diarra M.S., Petitclerc D., Lacasse P. (2002).** Effect of lactoferrin in combination with Penicillin on the Morphology and the Physiology of *Staphylococcus aureus* Isolated from Bovine Mastitis. J. of Dairy Sci. 85: 1141-1149.

[21] **Dionysius D.A., Herse J.B., Grieve P.A. (1991).** Extraction of lactoperoxydase and lactoferrin from whey using batch ion exchange techniques. The Australian Journal of Dairy Technology, 46, No 2, November, 72-76.

[22] **Djangabilov., A.K., Bekishewa A.C., Mamirova T.N. (2000).** Medicinal properties of camel milk and Shubat. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100-101.

[23] **Elagamy E.I., Ruppanner R., Ismail A., Champagne C.P., Assaf R. (1996).** Purification and characterization of lactoferrin, lactoperoxydase, lysozyme and immunoglobulins from camel's milk. Int Dairy J., 6, 129-145.

[24] **Elagamy E.I. (2000).** Effect of heat treatment on camel milk proteins with respect to antimicrobial factors: a comparison with cow's and buffalo milk proteins. Food Chemistry, 68 277 – 232.

[25] **Elass-Rochard E., Roseanu A., Legrand D. *et al.* (1995).** Lactoferrin-lipopolysaccharide interaction: involvement of the 28-34 loop region of human lactoferrin in the high-affinity binding to Escherichia coli 055B5 lipopolysaccharide. Biochem. J. Dec. 15 ; 312 (Pt 3) :839-845.

[26] **El-Gawad I.A.Abd, El-Sayed E.M., Mahfouz M.B., El-Salam A.M. Abd. (1996).** Changes of lactoferrin concentration in colostrum and milk from different species. Egyptian Journal of Dairy Sciences, 24:297-308.

[27] **Elkhidir H.E. (2002).** Vitamine C status in Sudanese camels. Utrecht Univ. Thesis, 89 p.

[28] **Elliot J.I., Senft B., Ergardt G., Fraser D. (1984).** Isolation of lactoferrin and its concentration in sows' colostrums and milk during a 21-day lactation. J Animal Sci., V.59, No4, 1080-1084.

[29] **Ellison R.T.3rd. (1994).** The effects of lactoferrin on gram-negative bacteria. Adv Exp Med Biol. 1994; 357:71-90.

[30] **Fillebben C., Dehouck B., Benaïssa M. et al. (1999).** Tumor necrosis factor-α increases lactoferrin transcytosis through the blood-brain barrier. Journal of Neurochemistry. Vol. 73, N°6, 2491-2500.

[31] **Hutchens T.W., Magnuson J.S., Yip T.-T. (1989).** Rapid purification of porcine colostral whey lactoferrin by affinity chromatography on single-stranded DNA-agarose. Characterization, amino acid composition and N-terminal amino acid sequence. Biochimica et Biophysica Acta, 999 323-329.

[32] **Kanyshkova T.G., Buneva V.N., Nevinsky G.A. (2001).** La lactoferrine et ses fonctions biologiques. Лактоферрин и его биологические свойства. Biochemistry, 66, 1, p.5-13. (en russe).
[33] **Kappeler S. (1998).** Compositional and structural analysis of camel milk proteins with emphasis on protective proteins. Diss. ETH No. 12947. Zurich.
[34] **Kappeler S.R., Ackermann M., Farah Z., Puhan Z. (1999).** Sequence analysis of camel (*Camelus dromedarius*) lactoferrin. Int Dairy J 9 481 – 486.
[35] **Kawakami H., Shimoto H., Dosako S.I., Sogo Y. (1987).** One-step isolation of lactoferrin using immobilized monoclonal antibodies. J. of Dairy Sci., 70:752-759.
[36] **Leitch E.C., Willcox M.D. (1999).** Lactoferrin increases the susceptibility of S. epidermidis biofilms to lysozyme and vancomycin. Curr.Eye Res. Jul; 19(&):12-9.
[37] **Li-Chan E.C.Y., Ler S.S., Kummer A., Akita E.M. (1998).** Isolation of lactoferrin by immunoaffinity chromatography using yolk antibodies. Journal of Food Biochemistry, 22: 179-195.
[38] **Linden G. (1994).** In Biochimie agro-industrielle. Valorisation alimentaire de la production agricole., D. Lorient. MASSON Paris Milan Barcelone, p.114-116.
[39] **Mahfouz M.B., Elham, M.El-Sayed, I.A.Abd, El-Gawad et al. (1997).** Structural studies on colostrum and milk lactoferrin from different species. Egyptian J. Dairy Science., 25, pp. 41-53.
[40] **Mal G., Suchitra Sena D., Jain V.K., Singhvi N.M., Sahani M.S., (2000).** Role of camel milk as an adjuvant nutritional supplement in tuberculosis patients. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 99.
[41] **Martynenko N.I., Yagodinswkaya S.G., Akhundov A.A., Charyev K.C., Khummenov O. (1977).** Contents of trace elements (cooper, manganese, selenium) in cultured chal and camel's milk and their clinical significance. Zdravookhranenie turkmenistana, 3, 20-22.
[42] **Mason P.L., Heremans J.F. (1971).** Lactoferrin in milk from different species. Comp. Biochem. Physiol., , 39, 119 – 129.
[43] **Murphy M.E., Kariwa H., Mizutani T. *et al.* (2001).** Characterization of in vitro and in vivo antiviral activity of lactoferrin and ribavirin upon hantavirus. J Vet Med Sci 63 (6): 637-645.
[44] **Niehaus M.D., Gwalteney Jr.J.M., Hendley J.O. *et al.* (2000).** Lactoferrin and Eosinophilic cationic protein in nasal secretions of patients with experimental rhinovirus colds, natural colds, and presumed acute community-acquired bacterial sinusitis. J. Clin. Microb., August, Vol. 38, No 8. p.3100-3102.
[45] **Palmano K.P., Elgar D.F. (2002).** Detection and quantitation of lactoferrin in bovine whey samples by reversed-phase high-performance liquid chromatography on polystyrene-divinylbenzene. (short communication) J. of Chromat. A., 947, 307-311.
[46] **Puzyrevskaya O.M., Saubenova M.G., Baizhomartova M.G., Baimenov E.K. (2000).** Microbiological and biochemical characterisation of shubat. Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 98.
[47] **Qian Z.-Y., Jollès P., Migliore-Samour D., Fiat A.-M. (1995).** Isolation and characterization of sheep lactoferrin, an inhibitor of platelet aggregation and comparison with human lactoferrin. Biochimica et Biophysica Acta. 1243 25-32.
[48] **Raman A., Bhatia K.L., Singh T.P., Srinivasan A. *et al.* (1992).** Purification, crystralization, and X-ray diffraction studies of lactoferrin from buffalo colostrums. Arch Bioch Bioph., vol. 294, No 1, April, pp. 319-321.
[49] **Shimazaki K.-I., Oota K., Nitta K., Ke Y. (1994).** Comparative study of the iron-binding strengths of equine, bovine and human lactoferrins. J. of Dairy Sci., 61: 563-566.
[50] **Singh P.K., Parsek M.R., Greenberg E.P., Welsh M.J. (2002).** A component of innate immunity prevents bacterial biofilm development. Nature. Vol. 417, 30 may 2002. www.nature.com.
[51] **Sorrentino S., D'Alessandro A.M., Maras B. *et al.* (1999).** Purification of a 76-kDa iron-binding protein from human seminal plasma by affinity chromatography specific for ribonuclease: structural and functional identity with milk lactoferrin. Biochimica et Biophysica Acta. 1430, 103-110.
[52] **Tu Y.-Y., Chen C.-C., Chang J.-H., Chang H.-M. (2002).** Characterization of lactoferrin from colostral whey using anti-LF antibody immunoaffinity chromatography. Journal of Food Sciences, vol. 67, No 3, 996-1001.
[53] **Urazakov N.U., Bainazarov S.H. (1974).** Tushchibek, the first clinic in history for the treatment of pulmonary tuberculosis with cultured camel's milk. Problemy Tuberkuleza, 2, 89-90.
[54] **Xiao R., Kisaalita W.S. (1997).** Iron acquisition from transferrin and lactoferrin by *Pseudomonas aeruginosa* pyoverdin. Microbiology. 143, 2509-2515.
[55] **Yagil R., Van Creveld C. (2000).** Medicinal use of camel milk-fact or fancy? Proc. of 2nd International Camelid Conference: "agroeconomics of camelid farming", 8-12 sept. 2000, Almaty (Kazakhstan), 100.
[56] **Yoshida S., Ye-Xiuyun. (1991).** Isolation of lactoperoxydase and lactoferrins from bovine milk acid whey by carboxymethyl cation exchange chromatography. J. of Dairy Sci., 74: 1439-1444.
[57] **Zagulki T., Lipinski P., Zagulska A., Broniek S., Jarzabek Z. (1989).** Lactoferrin can protect mice against a lethal dose of *Escherichia coli* in experimental infection in vivo. Br. J. Exp. Pathol. Dec., 70 (6):697-704.

Internet Sites

b. W.Brink. Lactoferrin Update. LE magazine april, 2001 http://www.lef.org.
c. BE Japon numero 266- 24 mars 2003 – Ambassade de France à Tokyo/ Agence pour la diffusion de l'information technologique (ADIT, http://www.adit.fr). BIOTECHNICA. Le bulletin de Veille n°6, Avril 2003 page 11. www.biotechnica.asso.fr/uplood/biotechnica/bv006.pdf.

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Artificial Nursing of Camel Calves: An Effective Technique for Calves Safeguard and Improving Herd Productivity

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Abstract. In Tunisia, camel (*Camelus dromedarius*) is raised in extensive system. This specie was embossed in arid and desert areas where other domestic species can not subsist and where nutrition is based mostly on natural range vegetation which is affected by rainfall. Although camel is the best animal for theses harsh conditions, productive and reproductive performances of this specie are strongly related to range productivity. Milk production is very limited during dry seasons and can not provide to calves requirements.

In extensive breeding system, dams calve every 24 months and rate of losses calves by predator or by milk shortage vary from 8 to 25%. During dry year, artificial nursing technique safeguard calves and insured comparable mean daily gain to those of suckling calves (593 g and 607 g, respectively).

In normal conditions, calves could be separated from dams at 3 to 7 days of age to receive reconstitute milk. This early separation allowed the insemination of 97.7 % of dams after 3 to 4 weeks postpartum. Consequently, the interval between calving was reduced to 14 months.

Theses results demonstrate the important possibilities to improve camel productivity. Higher camel production constitute the better mean to incite young breeders whose are more anxious to the profitability of their activities.

Introduction

Calf is the main product of extensive camel breeding system in Tunisia as well as in many others African and Asian countries. Numerical productivity is low due to the low calving rate, which is lower than 0.45 per female per year, and the relatively high rate of calves loss mainly during dry seasons [6,10,3]. It is more difficult to improve calving rate than to reduce calves loses. In many species of ruminant, maternal milk was substituted by powder milk for different reasons. The artificial nursing technique was used to safeguard camel calves in case of mother milk shortage and also to improve she-camel reproductive performances [8,9,1,4].

This communication aimed to review camel calves nursing technique and it's effects on calf growth and female reproductive parameters.

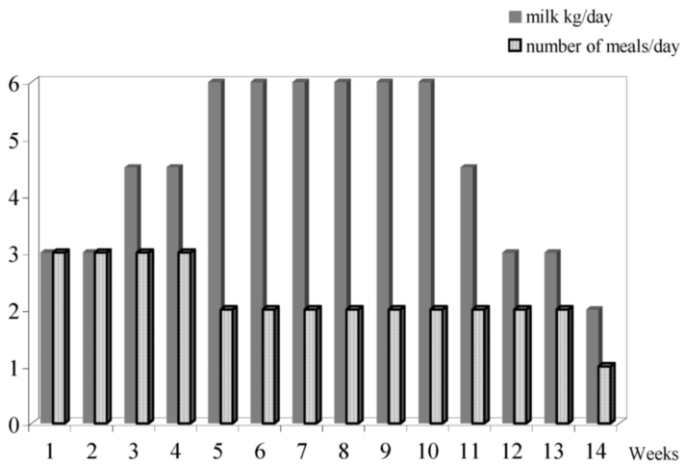

Figure 1. Distribution program.

1. Separation of Calves

Separation should occur 3 to 7 days after calving to guarantee immunity for the calf, by suckling mother colostrums. However, in case of mother death or milk shortage, calf is immediately brought to nursery.

2. Preparation of Milk Substitute and Feeding Program

The artificial milk used for cow calves was reconstituted in ratio of 120 dry matter to 1 l of warm water (50°C). After mixture and filtration, milk was cooled to about 37°C before delivery. In the first two weeks, milk was given to calves in bottle raised for human baby then in seal with teats.

The distribution program of milk is shown in figure 1. To avoid diarrhoea, it is necessary to always clean all material, mix and filter milk carefully and respect the requested temperature at delivery. Weaning occurs after 14 weeks in nursing station and each calf may consume about 50 kg of milk powder.

Since the third week after separation commercial concentrate or an ordinary mixture (barley: 80%, wheat bran: 15%, mineral & vitamine: 5%) may be offered with a good quality fodder like *Medicago sativa* hay. Solid feeds allow calves to sufficiently develop the rumen and their capacity to digest theses feeds witch became the main source of nutrient after weaning [4,7]. Camel calves seems adapted to an early valorisation of forage [3].

The effects of early separation of calves on their growth and the reproduction parameters of females in two experiments conducted in Arid Land Institute (IRA) will be presented.

3. Effect of Early Separation and Artificial Nursing on Growth of Camel Calves

Experiment 1: Growth of camel calves during 3 months was compared for 27 claves in artificial nursing (group 1) and 15 calves kept with dams (group 2). Live body weight (LBW) at 15 and 90 days age averaged 41.5 vs. 46.2 kg and 84.2 vs. 92.1 kg respectively for group

Table 1. Effect of artificial nursing on growth of camel calves (experiment 1).

LBW (kg) Daily gain (g)	**Group 1**: calves in artificial nursing		**Group 2**: calves with dams	
			n	mean
LBW 15	27	41.5	15	46.2
LBW30	27	48.5	15	60.1
LBW60	27	65.2	15	77.7
LBW90	27	84.2	15	92.1
DG 15-30	27	462	15	912
DG 30-60	27	594	15	586
DG 60-90	27	643	15	484
DG 15-90	27	593	15	607

Table 2. Effect of artificial nursing on growth of camel calves (experiment 2).

LBW (kg) Daily gain (g)	**Group 1**: calves in artificial nursing		**Group 2**: calves with dams	
			n	mean
Birth weight	8	29.6 (1.3)a	10	29.5 (4.3)a
LBW30	8	40.8 (2.3)c	10	50.3 (7.5)a
LBW90	8	81.8 (4.9)ab	10	87.2 (8.8)a
LBW120	8	101.6 (6.6)a	10	107.2 (9.9)a
LBW180	8	133.8 (12.5)a	10	136.7 (19.0)a
DG 0-90	8	580 (47)a	10	639 (85)a
DG 90-180	8	578 (134)a	10	549 (183)a
DG 0-180	10	579 (64)a	15	594 (105)a

1 and group 2 (table 1). During the first two weeks after separation, daily body gain (DBG) was higher in group 2 than in group 1. This may be explained by the difficulty of adaptation of calves in the artificial nursing station. DBG was not significantly ($P>0.05$) different between the two groups during the next 30 days (594 vs. 586 g in group 1 and group 2, respectively). In fact, DBG was higher in group 2 than in group 1 during the third month due to the drop of she-camels milk production in the beginning of the dry season. In the two groups, DBG during the whole period was comparable ($P>0.05$). It averaged 593 g and 607 g for group 1 and group 2, respectively.

Experiment 2: In this experiment, life body weight (LBW) and daily body gain in 10 calves nursed artificially (group 1) and 8 calves kept with dams (group 2) were compared. At 30 days old, LBW was significantly higher ($P<0.05$) in group 2 than in group 1 (40.1 vs. 50.3 in group 1 and group 2, respectively). This difference alleviate at 3 months old for the same reason mentioned in experiment 1 (table 2). After weaning, DBG of calves in group 1 did not change but that in group 2 decreased, but difference between the two groups was not significant.

At 6 months old, BLW and DBG were 133.8 vs. 136.7 kg and 579 vs. 594 g in group 1 and group 2, respectively. Theses findings are lower than those reported by Shareha [11], 174.6 vs. 172.1 kg for males and females respectively in pastoral Libyan condition. DBG was also higher, 658 vs. 758 g in the same conditions.

DBG in the extensive breeding system is very friendly with rainfall, thus in 2004, the DBG of camel calves during the first 6^{th} months age in IRA experimental herd was 827.4 ± 87.9 g (n=4) due the good climatic conditions in the south of Tunisia.

Results of the two experiments showed that in the beginning, calves need about 2 weeks to be adapted to artificial nursing conditions and DBG was low. After that, DBG increased

Table 3. Effect of early separation of camel calves on reproductive performance of she-camels (experiment 1).

Parameters	Number or % of she-camels
Mated females	17
Pregnant females	13
% of Pregnant females	76.8
Interval between separation and mating (day)	9.07 (7.77)
Interval calving-mating (day)	17.92 (9.11)

( ): Standard deviation

and LBW at 90 days old was not different to that observed in calves with dams. In fact, after the adaptation period, DBG was higher in calves in nursing station than those with dams and milk production of suckling females decreased in the beginning of the dry season.

After weaning, DBG in artificial nursing calves did not decreased unless good feeds are not available. Separation of calves during about 3 months alters social behaviour since theses animals are often separated from the rest of the herd witch not appreciated by the keeper. This behaviour will be lost after few months. To resolve this problem, we advise, mainly when the objective of the artificial nursing is to improve camel productivity, to select male calves witch may be fattened after the nursing period. Fattening camel calves is now encouraged in Tunisia to reach legal BLW (250 kg) at slaughtering and to get better contribution of camel meat to satisfy population requirements.

4. Effect of Early Separation of Camel Calves on Reproductive Performance of She-Camels

Experiment 1: The effect of early separation of calves on reproductive parameters was studied on a total of 17 dams (table 3). Among 17 mated females, 13 were pregnant 9.07 ± 7.77 days after weaning and interval between calving and conception was 17.92 ± 9.11 days. However, no dam in suckling females group (group 2) was pregnant. Consequently, the interval between calving was 403.5 ± 8.2 days *vs*. 714.6 ± 30.7 days in non suckling females group (group 1) and in suckling females group (group 2), respectively. These results clearly demonstrate that early separation of camel calves is an effective technique to induce heat, to increase conception rate and to reduce interval between calving by about 10 months.

It well documented that dam accepts the male for mating 10-12 days after weaning [1] but incomplete uterine involution could limit conception rate [2].

Experiment 2*:* The effect of early separation of calves on suckling dams was studied to confirm good results in experiment 1. In this experiment, there were 7 and 10 females in group 1 group 2, respectively. In the first group all dams were mated and pregnant. In the second one, 5 dams were mated but only 3 dams were pregnant (table 4). The interval between calving and first mating (IC1M) averaged 9 ± 6 vs. 40 ± 15 days in group 1 and group 2, respectively. Successfully mating (ICSM) occurs 29 ± 10 vs. 89 ± 33 days after calving in group 1 and in the three females of group 2. IC1M and ICSM for the females in group 2 not mated in the calving season averaged 252 ± 27 and 300 ± 35 days, respectively. In Libyan range conditions, Hermas [3] reported that interval between calving and first service is equal to 234 ± 15 days and conception mating occurs after 287 ± 13 days.

These results confirm also the positive effect of early separation on inducing heat 1 to 2 weeks on dry females besides its effect on the safeguard of threatened young camel calves in harsh conditions.

Table 4. Intervals between calving and 1st mating (IC1M) and successfully mating (ICSM).

Parameters	Group 1	Group 2
N	7	10
Mated females	7	5
Intervals between calving and 1st mating	9 (6)	40 (15)
Pregnant females	7	3
Intervals between calving and successful mating (IMBSF)	29 (10)	89 (33)

( ): Standard deviation
group 1: dams suckling
group 2: dry dams (calves nursed with milk powder)

Conclusion

Camels have an important role in Tunisia as well as in others similar climatic countries which are threatened by desertification. Camels valorize and preserve fragile ecosystems in arid zones. Productivity could be improved by new techniques: early separation and artificial nursing of calves by reducing interval between calving. This technique doesn't affect daily body gain of calves. Artificial nursing of calves is easy and don't need a specific equipments.

References

[1] **Elias, 1993.** Early weaning and postpartum conception in the one-humped camel: review. Actes de l'atelier "Peut-on améliorer les performances de reproduction des camelins", Saint-Martin (Ed). Publ. Cirad-Emvt, Coll. Synthèses de l'EMVT, n° 41, p. 239-254.
[2] **El Wishy, 1987.** Reproduction in the female dromedary: a review. Anim. Reprod. Sci., 15, 273-297.
[3] **Faye B., 1997.** Guide de l'élevage du dromadaire, CIRAD, première édition, 126 p.
[4] **Hammadi M., 1995.** L'allaitement artificiel des chamelons : une technique pour améliorer la productivité de l'élevage camelin. 1992. Options méditerranéennes, Série B, 13, pp: 137-141.
[5] **Hermas S., Shereha A., Biala A., Saad A., 1990.** Growth measures in Magrebi camel in Libya. Proc. Intern. Conf. Camel Prod. Improve. 10-13 Dec. 1990. Tobruk, Libya, pp: 73-181.
[6] **Ismail M., 1990.** Situation et perspectives de l'élevage camelin en Tunisie. Revue des Régions Arides, pp: 115-134.
[7] **Khorchani T., 1999.** L'allaitement artificiel : moyen de sauvegarde du jeune et d'amélioration de la productivité du dromadaire. Séminaire de développement de la production du dromadaire en Syrie, Hama, 14-15 avril, *Ed*. Conseil Supérieur des Sciences, pp: 135-141.
[8] **Khorchani T., Hammadi M., Moslah M., 1991.** Principaux résultats de recherche de l'Institut des Régions Arides sur l'amélioration de la productivité des dromadaires (arabe). Séminaire National sur l'élevage camelin. Douz (Tunisie) 29-30 Décembre 1991, pp: 16-21.
[9] **Moslah M., 1993.** Amélioration de la productivité du dromadaire en Tunisie. Atelier : "Peut-on améliorer les performances de reproduction des camelins?" Paris, 10-12 Septembre 1990, pp: 225-238.
[10] **Moslah M., Megdiche F., 1989.** L'élevage du dromadaire en Tunisie. Options méditerranéennes, Série séminaires, 2, pp: 33-36.
[11] **Shareha A. M., 2000.** Camel in Arab countries, *Ed*. Fateh University Libya 539 p.

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Camel Dairy in Eastern Africa: Present State and Future Perspectives

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Abstract. There are about 17 million camels in the World, of which 13 million are found in Africa and 4 million in Asia. Of this estimated world population, 15 million are believed to be one-humped dromedary camels (Camelus dromedarius) and 2 million two-humped (Camelus bactrianus).

Approximately 11 million dromedaries, representing two thirds of the world's camel population, are in the arid areas of Africa, particularly in North East Africa.
In many arid areas, camels play a central role as milk suppliers. In absolute terms the camel produces more milk and for a longer period of time than other species maintained in the same environment.

Milk yields per day varying from 3.5 kg for animals under desert conditions up to 18 kg for animals in irrigated land are reported. In the context of advancing urbanisation, camel milk is increasingly commercialised in the informal market in urban areas. Besides fresh, camel milk is often sold and consumed in the form of fermented milk. The milk is of poor hygienic quality due use of unclean containers, long transport and high ambient temperatures. This results in a potentially high health risk to the public through spread of zoonotic infections and food poisoning agents. Due to increasing camel milk consumption in urban and pre-urban areas there is a growing interest in the introduction of appropriate conservation and storage methods, to improve the hygienic safety and shelf life of the commercialized milk. The paper will discuss the present limiting factors for building up modern camel dairy and possible options for improvement.

1. The Camel as a Milk Animal

According to FAO statistics [1] there are about 17 million camels in the World, of which 13 million are found in Africa and 4 million in Asia. Of this estimated world population, 15 million are believed to be one-humped dromedary camels (*Camelus dromedarius*) and 2 million two-humped (*Camelus bactrianus*).

Approximately 11 million dromedaries, representing two thirds of the world's camel population, are in the arid areas of Africa, particularly in Eastern Africa.

In this region, camels play a central role as milk suppliers. The comparative advantage of the camel as a dairy animal over the other species in the same environment is well documented and it is widely recognised that in absolute terms the camel produces more milk and for a longer period of time than other species maintained in the same environment.

Daily yields between 3 and 10 kg in a lactation period of 12 to 18 months are common. Considering the local feed base in arid areas which is frequently inadequate, such yields are impressive, and indicate that the camel is a better milk animal than African Zebu cows held

under the same environmental conditions with daily milk yield between 0.5 and 1.5 kg [2,20].

The gross composition of camel milk is similar to that of cow milk and the ranges given in the literature are: dry matter 9.8 - 14.4%, protein 2.7 - 4.5%, fat 3.2 - 5.5%, lactose 4.0 - 5.6% and ash 0.6 - 0.9%. The average casein and whey protein content in camel milk varies between 1.9 and 2.3%, and 0.7 and 1.0% respectively [2].

Comparison to bovine milk proteins revealed pronounced differences in quantitative distribution of casein and whey proteins. ß-casein was found in higher concentration than in bovine milk, whereas k-casein amounted to only 3.5% of the casein fraction. The whey proteins mainly consist of α-Lactalbumin, serum albumin and lactophorin (PP3 protein). B-lactoglobulin the main whey protein of bovine milk is not found in camel milk.

Camel milk casein differs from cow milk casein in terms of micellar size distribution. Electron microscopy studies showed a relatively broad size distribution of casein micelles in camel milk with a greater number of large micelles than cow milk [3].

Only fragmentary information is available on minerals and vitamins in camel milk. Data available indicate that camel milk is rich in chloride and phosphorus and low in calcium. The vitamin C content in camel milk is twice as high as in cow milk. The availability of a relatively fair amount of vitamin C (range reported in the literature 25 - 60 mg/l) in camel milk is of significant relevance from the nutritional standpoint in the arid areas, where fruits and vegetables containing vitamin C are scarce [15,4].

2. Traditional Products

In pastoral societies, milk is traditionally consumed predominantly in the form of fermented milk. Fermentation is the only means of preserving milk under warm conditions. As fermented milk can be made from more than one domesticated species of animals, it is often unclear in the literature whether only camel milk has been used or if it is mixed with milk from other animals. Therefore, there are very few reports describing fermented products clearly made from camel milk.

In eastern Africa, however, where 60% of the world camel population are held, there is a long tradition in preparing fermented camel milk camel. The milk is either home-consumed or sold in the immediate vicinity of the herd.

To prepare fermented camel milk, containers of calabas, cly potes, plant fibre vessels or hollowed wood vessels are smoked by burning chips of *Olea africana* or *Acacia busia*. In some areas, the hot smoking chips are introduced into the vessel and whirled inside for a few minutes with the lid of the vessel on. In other cases, the vessel is inverted over the smoking chips until the smoke dies out.

The practice of smoking milk vessels is common in eastern Africa and appears to have value in disinfecting the utensils as well as contributing a smoky flavour to milk products.

The daily residual fresh milk is poured into the milk container. No starters are used and acidification develops after a few days, either from natural flora of milk when it is not boiled, or from the bacteria growing on the sides of the vessel.

The milk is left in a quite place, often in a covered container sheltered from dust for usually 24-48 hours until it becomes sour. The ambient temperature is normally between 25 and 35°C. Due to spontaneous nature of the fermentation, this traditional method results in a product with varying taste and flavour and often of poor hygienic quality.

Contrary to fermented milk, the manufacture of butter and cheese from camel milk is not a tradition in most of the pastoral societies in eastern Africa; these products are normally obtained from cow, goat and sheep milk.

3. The Commercialisation of Camel Milk

In eastern African countries (Kenya, Somalia, Sudan and Ethiopia) where most of the world's camel population are kept camel milk plays a central role in food security. In the context of advancing urbanisation camel milk is increasingly commercialised and consumed in urban areas. The camel milk suppliers are the nomadic pastoralists. Traditionally nomadic settlements are transient their movements depend on where they can find adequate pasture and water for their herds. However, this picture of "moving" nomads has changed in recent decades. With growing urbanisation the demand for milk among the city population has been increasing. On the other hand the demand for a number of goods such as grain, oil, sugar, clothes and other" things of the town" has increased among the pastoralists and milk sales have became the most important part of cash income for many camel owning pastoralists [19,11].

Studies on camel milk market [9] showed how camel milk outweighed other milk types in rural pastoral areas during the dry season.

In these studies two types of camel-oriented dairy systems in Somalia and Northern Kenya are described.

One consists of wide ranging nomadic herders who from time to time during their seasonal migratory movement pass through the "milk catchments areas" surrounding settlements, where they sell their milk surplus.

The other is more intensive camel dairying and is based on semi-stationary camel herds established near urban centres around towns in regions with adequate pasture and water. In a herd there are approximately 10 to 100 lactating camels and the milk is marketed through urban milk traders who collect the milk and sell it in the urban centres. These semi-stationary herds regularly exchange camels with dry herds that utilise more remote grazing areas to ensure that limited pasture near markets is used by lactating camels.

There are no reliable data on the amount of camel milk marketed in Somalia and Kenya. Estimates of total annual camel milk production are in the order of 935 million litres for Somalia and 320 million litres for Kenya.

4. Milk Hygiene

Camel milk production areas are often located far from markets. Distances to provincial markets range from 20 to 90 km and may be up to 400 km for distant urban markets. During periods of milk surplus (rainy season) transport on dirt roads is unreliable resulting in breakdowns and delays in milk delivery. Storage in unhygienic containers, pooling of milk from different suppliers, prolonged transport times and high environmental temperatures all increase contamination and spoilage of milk.

This results in considerable losses in marketed camel milk caused by frequent spoilage due to the absence of appropriate conservation and storage methods. In addition the presence of zoonotic infectious diseases in camels results in a potentially high health risk to the public.

The monitoring of hygienic quality of camel milk from pastoral production areas by performing Total Bacteria Counts (TBCs) has serious logistical problems because of the distances to the laboratory. Hence bacterial counts in milk from pastoral regions must be interpreted with caution. The figures presented here almost certainly reflect higher TBCs than originally present in the samples. Spoiled camel milk has been found to have TBCs of 10^7 cfu/ml to 10^8 cfu/ml, although milk with lower TBCs is occasionally perceived as spoiled by organoleptic testing. The results of Coliform Counts (CC) are even more affected by the delays before laboratory testing CC's of less than 100 cfu/ml have been found in milk samples from traditional milking buckets [21].

Table 1. Total bacteria counts (TBC) in camel milk in Kenya.

Milk sample	TBC* (cfu/ml)
From udders milked directly into clean container	10^2-10^4
From traditional milking bucket	10^3-10^4
From transport container immediately after end of milking	10^4-10^5
From bulk milk stored 24h without cooling	10^5-10^8
From milk purchased:	
- in the production area (less than 24h old milk)	10^6-10^7
- in Nairobi (24h to 36h old milk)	10^6-10^8

*** For comparison:** **EU - Standard for raw cows milk** TBC < 10^5 cfu/ml

The following is a compilation of examples from camel milk analysis (Table1).

These results show that good quality raw camel milk is produced but it deteriorates rapidly as it enters the informal marketing chain. Pooling of different raw milk batches and unhygienic plastic containers accelerate spoilage with non-refrigerated bulk milk reaching a TBC of 10^8 cfu/ml and turning sour in less than 24 hours at 25C° or in less than 12 hours under hot conditions (35°C).

5. Future Perspectives

5.1. Improvement of Milk Hygiene

Good quality dairy products can be obtained only from milk of high hygienic quality. This makes the improvement of milk hygiene the pre-requisite for any future camel dairy development.

Optimising milk hygiene under pastoral conditions requires the availability of safe clean water, an unrealistic expectation in most situations. However, the introduction of the following simple milk handling techniques showed to have measurably positive effect on raw milk quality:

- Replacement of cheap plastic with quality steel containers for storage and transport
- Filtration of milk with disposable clean gauze/paper filters
- Rotation of sealed sanitised containers between production areas and dairy processors
- Short heating/flash boiling of raw milk at primary collection sites
- Reducing milk temperature at primary/secondary collection sites using solar or gas-powered refrigerators, evaporative cooling from charcoal-walled cooling chambers or simply by wrapping milk containers in a moist cloth, provision of shade/cooling box during vehicle transport
- Encouraging the use of quality steel buckets or traditional “smokable” milking buckets rather than plastic milking buckets in the producing herds, using only boiled water as hot as possible for final cleaning of storage-containers in milk producing herds
- Training and extension to raise awareness among producers on clean milking and handling practice; accelerated transport from production to market
- Milk must be excluded from processing if the animal is infected with: Brucellosis, mastitis or Tuberculosis. The milk must also not be used if it contains colostrum, veterinary drug residues and if the animal has been vaccinated within the previous 24 hours.

Table 2. Comparison of LPS treated and untreated camel milk. Split milk batch, transport time: 8.45 a.m. – 2.30 p.m., milk temperature: 31.4°C ↘ 27.6°C (no cooling).

	Milk Quality (Resazurin 10 min Test - Result)	
Milk treatment	post-milking	arrival at the dairy
None	5 = *good for pasteurisation*	3 = *unfit for pasteurisation*
LPS – treated	5	5

- Before milking, the udder of the animal must be washed with lukewarm water and disinfectant and wiped clean-dry with a cloth used for this and no other purpose. The milker's hands must also be washed and disinfected.

5.2. Use of LPS in Milk

Milk contains several antibacterial factors, the most well known being the immunoglobulins. Other antibacterial agents are lysozyme, lactoferrin and lactoperoxidase. Lactoperoxidase has no antibacterial effect on its own, but combined with oxidized thiocyanat and hydrogen peroxide, the resulting chemical reaction creates antibacterial compounds which can inhibit or eliminate bacteria in milk. These three components which from LPS-System can be reactivated by adding defined quantity of thiocyanate and hydrogen peroxide in milk for effective raw milk preservation during collection in Developing Countries. Addition of thiocyanate up to 10 ppm and hydrogen peroxide up to 8 ppm into raw milk was approved by the Codex Alimentarius Commission in 1991.

The introduction of the Lactoperoxydase System (LPS) to the camel dairy can improve milk quality prolong the shelf life of camel milk. Currently there is one camel milk dairy in the Puntland state of Somalia successfully utilising a combination of cooling and LPS treatment for preserving raw camel milk transported to the dairy plant from as far as 400 km distance. The effectiveness of the LPS- treatment was tested by resazurin.

The test is based on the speed at which milk changes colour as a result of the reaction between resazurin and the bacteria. The colour change is read in a comparator which gives readings in six classes. Table 2 shows that LPS treated milk is still fit for pasteurisation after 6 hours transport time.

6. Product Improvement

6.1. Fermented Milk

As already stated, camel milk is consumed mainly in fermented form. The fermentation is spontaneous and can result in undesirable products that are sometimes even risky or dangerous for human health. The reasons being that the final quality and safety of the fermented product are dependent on factors such as: (i) quality of the raw material; (ii) initial level of contamination (which in turn depends on local conditions); (iii) levels of hygiene and sanitation; (iv) quality of the starter culture; (v) conditions of fermentation (e.g. temperature); and (vi) degree of acidity achieved [12,17]. These parameters are very difficult to control, particularly when processing is carried out under the rudimentary conditions of some small-scale industries or under household conditions. To improve this spontaneous traditional fermentation, controlled fermentation using mesophilic lactic acid bacteria LAB starter culture can be introduced. In warm countries, mesophilic culture offers advantages as it can be incubated at ambient temperature. LAB starter cultures are not yet commer-

cially available for the small-scale fermentation of traditional African fermented milk or other foods. The introduction of appropriate starter culture techniques will certainly be one major step towards improved safety, quality and security of traditional small-scale fermentation.

6.2. Cheese

Most attempts to make cheese from camel milk have revealed major difficulties in getting the milk to coagulate. With the same amount of calf rennet, the coagulation time of camel milk is two to three-folds longer than in cow milk. The action of rennet on camel milk leads to coagulation in the form of flocs, with no firm coagulation [5,15,18].

There are some reports in the literature showing that clotting enzyme from one species is more effective and specific with milk from the same species. Chymosin from lamb where found to be more effective with lamb milk than with cow milk [10]. Pig chymosin and pig pepsin have shown higher milk clotting activity against porcine milk than against bovine milk [8]. These findings suggest an adaptation between the proteolytic specificities of the gastric proteases and the structure of the caseins. Accordingly, it can be expected that camel chymosin would be more effective in camel milk than calf chymosin. Following this, Kappeler and Farah [14] developed recombined camel chymosin, from mRNA, obtained from the stomach of a young camel. The process has been patented. After the preliminary tests in laboratory showed the effectiveness of the enzyme, field studies for making cheese from camel milk are now going on in some east African countries.

6.3. Butter

Like cheese, butter is also not a traditional camel milk product as is it difficult to obtain camel milk butter following the same preparation procedures as for cow's milk. This is due to the lake of agglutinin a protein which promotes clustering of fat globules and formation of cream layer in cold milk. Also the high melting point (41-42°C) of camel milk fat makes difficult churning camel milk cream in temperatures commonly used for churning cow milk. Farah and Streiff [7] developed simple method for manufacturing butter from camel milk fat. According to the method, butter was obtained by churning camel milk cream at temperatures between 20 and 25°C. This temperature is considerably higher than that of cow milk which normally varies between 8 and 12°C.

6.4. Heat Treated Product

There are very few studies on the effect of heat treatment on the proteins of camel milk. Available data indicate that the whey proteins in camel milk are more heat resistant than in cow milk [6]. In this study the milk was pasteurised to 63, 80 and 90°C for 30 mints, and the effect of heat on the whey proteins determined by Polyacrylamide gel Electrophoresis. Under the selected experimental conditions the rate of heat Denaturation of camel milk whey proteins was approximately twofold lower than cow milk whey proteins. This indicates that camel milk can be easily pasteurised, and there are commercial small and middle scale camel milk processing plants for production of pasteurised milk in Mauritania, Kenya and Somalia.

On going investigation to study the ability of camel milk to withstand ultra-high processing temperatures UHT showed heat instability of camel milk. Bulk camel milk collected from camels in Kenya were UHT heat treated applying both direct (150°C/2 sec.) and indirect (138°C/8-10 sec.) method. After processing the milk was stored at 5, 10, 25 and 30°C for five weeks. After 3 weeks, milk stored at 25 and 30 °C separated forming fine deposit

which was more in milk processed by indirect method then the direct. No deposit formation was observed in milk stored at 5 and 10°C even after 5 weeks storage. This heat instability of camel milk at high processing temperatures can be due to the low content of K-casein and the total absence of β-Lactoglobulin in camel milk. Both proteins play an important role in the heat stability of bovine milk.

Our conclusion so far is that camel milk cannot be UHT treated following the same procedure as in cow milk.

7. Concluding Remarks

Consumer consciousness about hygienic quality of camel milk has yet to develop. However, there are indications that urban consumers begin to value good hygienic quality of camel milk and are also ready to pay more for better quality.

Selling heat treated packed camel milk could provide the solution to hygiene woes and at the same time eliminate zoonotic risks to camel milk consumers.

The problem faced by any fixed milk processing plant is to ensure the sufficient and regular supply of raw milk with acceptable quality from mobile lactating camel herds. The concept of centralised modern milk processing plants may also lead to over-concentration of lactating camel herds in a limited grazing area with severe negative impact on the very fragile environment and increased disease prevalence in the animals. Decentralised and maybe mobile processing systems relying on simple adapted technology should be developed and tested.

References

[1] **FAO** (1999). FAOSTAT DATA, Statistical databases on the internet, address: http//apps.fao.org/lim500/Agri_db.pl, Rome, Italy.
[2] **Farah, Z.** (1996). Camel milk: Properties and products, SKAT-Verlag, St. Gallen, Switzerland.
[3] **Farah, Z., Rüegg, M.W.** (1989). The size distribution of casein micells in camel milk. Food Microstructure 8 (8), 211-216.
[4] **Farah, Z., Rettenmayer, R., Atkins, D.** (1992). Vitamin content of camel milk. Intern. J. of Vitamin and Nutr. Res. 62, 30-33.
[5] **[5] Farah, Z., Bachmann, M.R.** (1987). Rennet coagulation properties of camel milk. Milchwiss. 42 (11), 689-692
[6] **Farah, Z., Atkins, D.** (1992). Heat coagulation of camel milk. J. Dairy Res. 59, 229-231.
[7] **Farah, Z., Streiff, T., Bachmann, M.R.** (1989). Manufacture and Characterisation of Camel Milk Butter. Milchwiss. 44 (7), 412-414.
[8] **Foltmann, B., Jensen, A.L., Lanblad, P., Smidt, E., Axelsen, N.H.** (1981). A developmental analysis of the production of chymosin and pepsin in pigs. Comp. Biochem. Physiol., 68B, 9-13.
[9] **Hashi, A.M.** (1988). The role of camel milk production in drylands. Camel Forum, working Paper Nr. 25, p. 5-6.
[10] **Herian, K., Krcal, Z.** (1971). Suitability of lams' stomachs for industrial manufacture of rennet. Prumysl-Potravin, 22 (5), 137-139.
[11] **Herren, U.J.** (1992).Cash from camel milk. Nomadic peaples, 30 97-113.
[12] **Holzapfel, W.H., Geisen, R. and Schillinger, U.** (1995). Biological preservation of foods with reference to protective cultures, bacteriocins and food grade enzymes. Int. J. Food Microbiol. 24, 343-362.
[13] **Kappeler, S., van den Brink, H., Rahbek-Nielsen, H., Budtz, P., Farah, Z., Puhan, Z., Johansen, E., Hansen, E.** (2003). Characterization of Recombinant Camel Chymosin Reveals Superior Properties for the Coagulation of Bovine and Camel Milk. Biochemical and Biophysical Research Communications, Submited.
[14] **Kappeler, S., Farah, Z.** (2002). Method of producing non-bovine chymosin. Patent: International Publication Number WO 02/36752 A2. Publication date 10.05.
[15] **Mehaia, M.A., Al-Kahnal, M.A.** (1989). Studies on camel and goat milk proteins: Nitrogen distribution and amino acid composition. Nutr. Report Int. 39 (2), 351-357.

[16] **Mohammed, M.A., Larsson-Raznikiewicz, M.** (1989). Separation of camel milk casein fraction and its relation to coagulation properties of fresh milk. Milchwiss. 44 (5), 278-280.
[17] **Motarjemi, Y., Assante, A.** (2002). Impact of small-scale fermentation technology on food safety in developing countries. Int. J. Food Microbiol. 75, 213-229.
[18] **Ramet, J.P.** (1991). Processing camel milk into cheese. Revue Mondiale de Zootechnie, no. 61, 21-28.
[19] **Samanter, M.S.** (1987). Camel milk supplay to Mogadishu, Somali. Camel forum, Working paper No. 21
[20] **Schwartz, H.J., Dioli, M.** (1992). The one-humped camel in Eastern Africa. Verlag Josef Margraf, Weikersheim, Germany.
[21] **Younan, M.** (2002). Camel Milk Hygiene. *In:* The camel (*C. dromedarius*) as a meat and milk animal: Handbook and product development. Farah Z., and Fischer, A. (Ed). Vdf Hochschulverlag ETHZ.

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Influence of Feeding on Camel Milk Components

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Abstract. In several arid and semi-arid zones of tropical and sub-tropical Africa and Asia, camel milk is a key nutrient resource for the human diet. Traditionally, camel nutrition is based on vegetable species they can browse or graze in natural pastures, often inaccessible to other domestic livestock, with little or no supplemental feeding. While camels are known to adapt well to low quality forage in a harsh environment, information on the influence of different feeding regimes on camel milk components is very scarce. Drinking water availability is the most important factor affecting the concentration of the various milk components. Differently from the milk of cows exposed to heat, milk from the dehydrated camel is more diluted, with decreased percentages of fat, protein and lactose. Little information is available on camel milk mineral composition, despite the fact that camel milk can be considered a potential source of minerals and trace elements for the human population in drought areas. In some zones of Africa, grazing camels can undergo some mineral deficiency, due to lack of certain minerals, markedly trace elements. Mineral supplementation can therefore be a useful practice. A study is reported, in which the effects of oral trace element supplementation on milk yield and composition in camels reared in Kenya were examined. Due to the substantial amounts of camel milk consumed in human nutrition, further research is needed to establish its nutritional value under different feeding conditions.

1. Camel Milk, a Nutritious Product for the Desert Inhabitants

Camels occupy a very important niche in the desert ecosystem. The ability of camels, especially one-humped camels or dromedaries (*Camelus dromedarius*) to adapt to extreme heat and aridity of the environment is unique amongst other domestic animals. In harsh environment, where water and feed availabilities are scarce and ambient temperature is very high, the dairy camel not only can survive but can benefit the desert inhabitants, producing milk for longer periods and in greater quantities than any other domestic animals, such as goats, sheep or cows, thanks to its particular physiology and browsing habits. The composition of its milk is of prime importance both for the young suckling camel and for the man who drinks it. In fact, in many desert regions of the globe, camel's milk plays a central role in the diet of the population, often representing the only source of high quality protein for human consumption.

Under desert conditions, in traditional pastoral systems, camels can produce 1500-2500 kg of milk within a lactation period of 9-18 months with a daily yield of 3-6 kg [9]. Nutritional factors can influence camel milk production. Diets rich in green forages can augment milk secretion [17], while water restriction can only marginally decrease milk yield [24]. Data on

camel milk gross composition reported in literature show high variability, reflecting differences in breed, stage of lactation and nutrition. In general, composition of camel milk is similar to that of cows and goats, but with some peculiarities of significant nutritional relevance. In particular, compared to cow's milk fat, camel milk fat has smaller quantities of short-chain fatty acids and higher contents of palmitoleic (C16:1), linolenic (C18:3 n-3) and long-chain (>20 carbon atoms) polyunsaturated fatty acids [16,6]. The high amounts of polyunsaturated fatty acids would account for some of the renowned health properties ascribed to camel milk. The elevate content of vitamin C (25-60 mg/l), substantially higher than in cow's milk, is also of particular nutritional relevance, especially in desert areas where fruits and vegetables containing vitamin C are scarce [9]. Few data are available on mineral composition of camel milk, despite the fact that it can be considered a potential source of minerals and trace elements for the human population in drought areas.

Information on the influence of different feeding regimes on camel milk components is very scarce. As in other dairy animals, also in camels it seems that "improved" or modern husbandry and diet can influence milk composition by lowering milk fat and protein percentages [19]. Drinking water availability is the most important factor affecting the concentration of the various milk components. Differently from the milk of cows exposed to heat, milk from the dehydrated camel is more diluted, with decreased percentages of total solids, fat, protein and lactose [24]. The milk dilution is a physiological response to heat and could be a natural adaptation to provide water to the dehydrated calf. It is of benefit also to the nomads of the desert who are in need of fluids.

2. Distribution and Management of Camels

Camels are distributed throughout African and Asian arid and semiarid tropics and subtropics, but the largest majority of one-humped camels, around 11 million, equivalent to two-thirds of the world's camel population, is to be found in the arid lowlands of Eastern Africa (Somalia, Sudan, Ethiopia and Kenya) [9]. There are three main management systems for camel herds, depending mainly on environmental factors. The first is the traditional or nomadic camel raising system where camels graze and browse the natural desert range. Most camel herds are kept with this system. Grazing camels have low feed requirements, consuming normally 5-12 kg of dry matter a day [13]. This system is the cheapest one and it is the only efficient way of exploiting many arid areas of north-eastern Africa, where crop cultivation is impossible. It can be made more profitable by introducing plants favourite of the camel (i.e. salt bushes) into the grazing areas or offering supplementary concentrate feeds (i.e. grains or fodder) in seasons of scarcity or as milk production rations. In the second system, herders live in villages where crop production is possible and camels are allowed to graze off the remains of crops. The third method is intensive, raising and breeding camels for milk production or racing in a stall system. With this system it is essential that an adequate feed supply be guaranteed, taking into account the high energy and protein demands for milk production.

3. The Food of Camels and Their Grazing Habits

In Eastern Africa, the great majority of camels are kept in traditional nomadic production systems and only a very small fraction is kept in modern commercial ranches under improved management techniques (i.e. supplementary feeding, mineral supplementation, regular watering, veterinary treatments, controlled reproduction). Their nutrition is based on vegetable species they can browse in natural pastoral lands. They can feed on leguminous trees

(*Acacia* sp.), large bushes, shrubs, salt bush plants, herbaceous plants and the feeds selected are generally rich in water content, nitrogen, electrolytes and oxalates [25]. A limitation imposed by the desert conditions is the reduced quantity and poor quality of the forage, liable to high seasonal variability. During the dry season, camels seem to adapt well to the harsh grazing conditions of natural pastures, surviving on thorny fibrous vegetation of low nutritional value [21]. According to the limited research on the subject, camels seem more efficient than other ruminants in digesting dry matter, crude fibre and cellulose and in re-utilizing digested nitrogen [14]. Camels are particularly able to select plants whose quality does not change greatly between seasons [8]. In fact, in a semi-arid thorn bush savannah of Northern Kenya, camels have been shown to feed selectively on dicotyledons of high digestibility also during the dry season, while other domestic ruminants, like zebu cattle, sheep and goats, were not able to reach the height at which the green vegetation was found and fed on monocotyledons of lower quality [22]. This particular feature of dromedary feeding behaviour, avoiding competition for the available forage with the other domestic grazing livestock, may help reducing the grazing pressure on the vegetation, especially in overgrazed areas.

4. Feeding Strategies for Dairy Camels in Eastern Africa: Trace Element Supplementation

The restraints imposed by the different environmental and social-economical conditions in which camels are raised should be carefully taken into account when planning new feeding strategies for camel milk production. Introduction of new plans of nutrition should be economically viable, first of all. Because of the scarce availability of local raw materials and of the high cost of transportation it is often very difficult to provide camels any supplemental food, i.e. concentrates. Anyway it is possible to feed camels mineral supplements, because the amount that must be fed is limited, 100-200 g/day, so that transportation is not such a great problem. This practice is useful because it is known that camels can undergo some mineral deficiency due to lack of certain minerals, markedly trace elements, in some zones of Africa, i.e. copper deficiency in the Rift Valley is well renowned.

Mineral requirements of camels are not well established [11], so it is difficult to formulate a proper mineral supplement to satisfy requirements and avoid possible deficiencies. Moreover, content and availability of trace elements in the pasture can vary in consequence of salt mineral content, season and vegetation state. This means that is very difficult to know the real amount of minerals that are available for the grazing animals daily.

In our nutritional study [7], undertaken in dairy camels supplemented with trace elements for the first nine months of lactation, we investigated: a) milk yield and composition; 2) mineral status of both lactating camels and their calves, assessed by analysis of plasma minerals.

For the trial, twelve multiparous lactating camels (Somali and Turkana breed and crosses) were selected from a herd in Kenya (Ol Maisor Ranch- Lakipia district) and divided into two groups. Camels assigned to control group received individually 200 g of a mineral salt containing phosphate, calcium, sodium chloride and magnesium oxide, without trace elements (table 1). Camels assigned to treated group received the same quantity of the same mineral salt, with the addition of trace elements: copper, zinc, cobalt and manganese sulphates, iodide, selenite, and iron carbonate, providing daily 1.4 g zinc, 350 mg copper, 1.75 g iron to each animal. The mineral salt was pelletted, mixed with molasses to improve palatability and orally administered daily in the evening, when camels were back from the pasture. We also controlled that the supplement was entirely consumed.

Table 1. Mineral mix composition and analysis.

Composition	Control	Treated
Sodium chloride, %	37.2	37.2
Calcium carbonate, %	18.6	18.6
Dicalcium phosphate, %	14.0	14.0
Monoammonium phosphate, %	9.3	9.3
Sodium phosphate, %	9.3	9.3
Magnesium oxide, %	4.6	4.6
Trace elements mix, %	---	7.0
Barley,	7.0	---
Ca %	10.90	10.89
P %	7.15	7.12
Na %	16.10	16.09
Mg %	2.42	2.39
Fe, mg/kg	---	8750
Zn, mg/kg	---	7000
Mn, mg/kg	---	7000
Cu, mg/kg	---	1750
I, mg/kg	---	420
Co, mg/kg	---	140
Se, mg/kg	---	35

Table 2. Chemical analysis of plant samples (% DM).

	DM	CP	NDF	ADF	EE	Ash
Rhus natalensis	42.07	9.73	61.26	44.61	1.16	7.59
Solanum icanum	27.39	17.70	53.26	34.11	1.60	8.58
Acacia seyal	52.74	14.34	42.99	23.81	1.51	7.47
Acacia brevispiga	50.97	19.03	54.21	33.26	2.08	5.03
Euclea divinorum	46.12	9.09	57.03	38.14	4.55	5.44
Carissa edulis	38.91	10.26	52.91	40.77	3.43	10.41
Thorns seyal	71.15	3.86	83.43	66.52	2.14	2.51

The observation of feeding behaviour indicated that the plants more frequently eaten by the dairy camels were: *Rhus natalensis, Solanum icanum, Acacia seyal, Acacia brevispiga, Euclea divinorum, Carissa edulis, Thorns seyal* (table 2).

Supplementation of trace elements did not affect milk yield and milk fat and protein contents (table 3). However, in the treated group, the pattern of milk response along the experimental period was more regular, peaking between the third and the fifth month of lactation. Our results for milk yield and fat and protein percentages are comparable with the data of other authors in similar environmental conditions [4,9].

Addition of trace elements increased zinc and calcium contents in milk, while iron and copper contents were not modified. The level of zinc in milk of supplemented cows (3.16 mg/l) is similar to the value observed in a Sudanese study (3.1 mg/l) [1] but lower than values indicated in other reports, ranging from 4.4 to 6.4 mg/l [23,2,18,15,3]. The increase of milk zinc in supplemented animals (3.16 *vs.* 2.52 mg/l) is consistent with the observation that it is possible to double milk zinc concentration in dairy cows by increasing zinc content of the diet [20]. In our trial the levels of copper in milk (0.37 and 0.40 mg/l) are markedly lower than levels reported in other studies, ranging from 1.2 to 1.6 mg/l [23,2,18], but similar to data recorded in a recent Kuwait study [3].

Table 3. Effects of trace elements addition on mean milk production variables.

	Control	Treated
Milk, kg/d	3.51	3.09
Fat, %	2.56	2.86
Protein, %	3.19	3.31
Ca, g/l	0.94^{A}	1.20^{B}
Mg, mg/l	37.18	41.11
Zn, mg/l	2.52^{A}	3.16^{B}
Cu,mg/l	0.37	0.40
Fe, mg/l	1.0	1.1

A,B P<0.01

Table 4. Effects of trace elements addition on plasma mineral content.

	Lactating camels		Calves	
	Control	Treated	Born from control camels	Born from treated camels
Ca, mg/100ml	9.29	9.50	12.66	11.75
P, mg/100 ml	8.64	8.57	-	-
Mg, mg/100 ml	2.61	2.66	1.98	1.98
Zn, µg/100 ml	33.46	35.90	65.30	58.94
Cu, µg/100 ml	32.32^{A}	37.60^{B}	43.17	48.13
Fe, µg/100 ml	133.85	135.12	127.78	137.92

A,B P<0.01

The effects of the administration of trace elements on plasma mineral content of lactating camels and calves are reported in table 4.

A very severe copper deficiency was found in control camels grazing in the area of our trial (32.32 µg/100 ml), considering that the threshold for copper deficiency in camels is 70 µg/100 ml [12]. Oral trace element supplementation significantly raised plasma copper concentration in lactating camels (37.60 µg/100 ml), but did not allow reaching, neither in plasma nor in milk, the threshold values. The area where our trial was performed is in the Rift Valley, which is an area highly deficient in copper [10] and this could probably explain the low levels that we observed.

Plasma zinc concentration of control camels was also very low (33.46 µg/100/ml), considering that zinc deficiency threshold is 40 µg/100ml [12]. The supplementation of trace elements did not change zinc status significantly (35.9 µg/100ml), in accordance with other studies [5,12]. Zinc plasma levels in calves were higher than in adults, probably due to the high level of zinc in camel's milk. In spite of the low zinc plasma levels, supplementation as zinc sulphate allowed to increase significantly the excretion of zinc in milk. The higher zinc level in the milk of the supplemented animals suggests that milk is a way for zinc excretion and could mean that probably camels are not deficient even if zinc plasma level is below 40µg/100ml.

In conclusion, camel milk is undoubtedly the most important camel product in many desert regions of the globe. Camel milk is of high nutritional value and, particularly in the arid environments of Eastern Africa, it often represents the only source of high quality protein for human consumption. Improving its content of essential trace elements could be of significant nutritional relevance, contributing to the prevention of severe malnutrition problems. Due to the relevant amounts of camel milk consumed, further research is needed to establish its nutritional value under different feeding conditions.

References

[1] **Abdel-Rahim, A.G. (1987).** Chemical composition and nutritional value of camel and goat milk. *World Review of Animal Production*, 23: 9-12.

[2] **Abu-Lehia, I.H. (1987).** Composition of camel milk. *Milchwissenschaft*, 42: 368-371.

[3] **Al-Awadi, F.M. and Srikumar, T.S. (2001).** Trace elements and their distribution in protein fractions of camel milk in comparison to other commonly consumed milks. *Journal of Dairy Research*, 68: 463-469.

[4] **Bachmann, M.R. and Schultess, W. (1987).** Lactation of camels and composition of camel milk in Kenya. *Milchwissenschaft*, 42: 766-768.

[5] **Bengoumi, M., Faye, B., Tressol, J.C. and Bengoumi, D. (1995).** Facteurs de variation des indicateurs plasmatiques du statut nutritionnel en oligo-éléments chez le dromadaire au Maroc. II. Effet d'une complementation minérale. *Revue Elev. Méd. vet. Pays trop*., 48: 276-280.

[6] **Cardak, A.D., Yetismeyen, A and Bruckner, H. (2003).** Quantitative comparison of camel, goat and cow milk fatty acids. *Milchwissenschaft,* 58: 34-36.

[7] **Dell'Orto, V., Cattaneo, D., Beretta, E., Baldi, A. and Savoini, G. (2000).** Effects of trace element supplementation on milk yield and composition in camels. *International Dairy Journal,* 10: 873-879.

[8] **Engelhardt, W.v., Abbas, A.M., Mousa, H.M. and Lechner-Doll, M. (1992).** Comparative digestive physiology of the forestomach in camelids. In: *Proc. 1st Int. Camel Conf., Dubai, 2-6th Feb. 1992*. (ed. Allen, W.R., Higgins, A.J., Mayhew, I.G., Snow, D.H. Wade, J.F.): 263-270. R & W Publications Ltd, Newmarket, UK.

[9] **Farah, Z. (1996).** Camel milk. Properties and products. Ed. SKAT. St.Gallen, Switzerland.

[10] **Faye, B., Grillet, C., Tessema, A., & Kamil, M. (1991).** Copper deficiency in ruminants in the Rift Valley of east Africa. *Tropical Animal Health and Production*, 23, 172-180.

[11] **Faye, B. and Bengoumi, M. (1994).** Trace-elements status in camels: a review. *Biological Trace Element Research*, 41:1-11.

[12] **Faye, B. and Bengoumi, M. (1997).** Données nouvelles sur le métabolisme des principaux éléments-traces chez le dromadaire. *Revue Elev. Méd. vét. Pays trop*., 50: 47-53.

[13] **Gauthier-Pilters, H. (1979).** Some ecological aspects of the camel in Western Sahara. *In: Camels. IFS Symposium*, Sudan: 387-398.

[14] **Gihad, E.A., El-Gallad, T.T., Sooud, A.E., Abou El-Nasr, H.M. and Farid, M.F.A. (1989).** Feed and water intake, digestibility and nitrogen utilization by camels compared to sheep and goats fed low protein desert by-products. *In: Séminaire sur la digestion, la nutrition et l'alimentation du dromadaire. Options méditerranéennes.* Série Séminaires n.2 : 75-81. CIHEAM, France.

[15] **Gorban, A.M.S. and Izzeldin, O.M. (1997).** Mineral content of camel milk and colostrum. *Journal of Dairy Research*, 64: 471-474.

[16] **Gorban, A.M.S. and Izzeldin, O.M. (2001).** Fatty acids and lipids of camel milk and colostrum. *International Journal of Food Science and Nutrition*, 52: 283-287.

[17] **Knoess, K.M. (1977).** The camel as a meat and milk animal. *World Animal Rev*., 22: 39-44.

[18] **Mehaia, M.A., Hablas, M.A., Abdel-Raham, K.M. and El-Mougy, S.A. (1995).** Milk composition of Majaheim, Wadah and Hamra camels in Saudi Arabia. *Food Chemistry*, 52: 115-122.

[19] **Merin, U., Rosen, B., Bernstein, S., Yagil, R. and Gollop, N. (1998).** Effects of husbandry practices on the composition of Israeli camel milk. *Milchwissenschaft,* 53: 680-682.

[20] **NRC (1989).** *Nutrient Requirements of Dairy Cattle*. 6th rev. Washington, DC: Natl. Acad. Sci.

[21] **Peyre de Fabregues, B. (1989).** Le dromadaire dans son milieu naturel. *Revue Elev. Méd. vét. Pays trop.,* 42: 127-132.

[22] **Rutagwenda, T., Lechner-Doll, M., Kaske, M., Engelhardt, W.V., Schultka, W. and Schwartz, H.J. (1989).** Adaptation strategies of camels on a thornbush savannah pasture: comparison with other domestic animals. In: *Séminaire sur la digestion, la nutrition et l'alimentation du dromadaire. Options méditerranéennes.* Série Séminaires n.2 : 69-73. CIHEAM, France.

[23] **Sawaya, W.N., Khalil J.K., Al Shalhat A. and Al-Mohammad H (1984).** Chemical composition and nutritional quality of camel milk. *Journal of Food Science*, 49: 744-747.

[24] **Yagil, R. and Etzion, Z. (1980).** Effect of drought conditions on the quality of camel milk. *Journal of Dairy Research*, 47: 159-166.

[25] **Wilson, R.T. (1989).** The nutritional requirements of camel. *In: Séminaire sur la digestion, la nutrition et l'alimentation du dromadaire. Options méditerranéennes.* Série Séminaires n.2 : 171-179. CIHEAM, France.

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Probiotic Properties of a Sour-Milk Product: Shubat from the Camel Milk

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Abstract. Camel breeding is traditional branch of animal breeding coming from the ancient times. It was developed on the territory of Kazakhstan as a result of natural, ethnic and nomadic traditions. Kazaks always consumed camel products such as meat, milk and wool. Fermentative treatment of camel milk is a part of ethnic traditions of Central Asia people. In Kazakhstan fermented camel milk is called shubat.

Chemical compound of camel milk is remarkably different from cows and other milks. Moreover, qualitative compound differs from the camel milk of African and Arabic camels. Fat consist in Kazakhstan camel milk is 4,5% in average with ranges 2,5-8% dependently on season and camel species. High fat concentration gives tender smooth consistent and specific taste. Existing data on vitamin and mineral composition and energy value differ from international data which is explained by difference in natural conditions and also by the different methodic of study.

Specific micro flora originates in shubat producing and the composition of this micro flora depends on raw milk, ferment and fermenting conditions. Complicated biochemical processes occur during fermentation of camel milk. These are milk sugar degradation and synthesis of new compound such as milk acid, alcohol and hydrocarbon and amino acids, increase of concentration of vitamins B_1, B_2, C. It was shown that shubat has bactericidal activity to pathogenic bacteria of intestinal group. Shubat is stimulator of activation of stomach secretions, it causes intensive gastric juices separation, has higher digestive properties and acidity than kefir and milk.

Lactic bacteria are probiotiques and they set friendly conditions for growth and stable existence of gut micro flora and also, in contrast to antibiotics, do not cause negative influence on normal gut microflora. Probiotiques have very important property to increase anti-infection resistance of organisms, in some cases they act as anti-allergic compounds and also act for regulating and stimulating digestion processes.

Introduction

Milk is the unique food provided an organism by mammals with all necessary nutrients. Milk and milk products take a significant place in human food, is used as the basic nutrition for children of early age and area part of different diets.

The basic properties of milk as food are:

- Good digestibility
- ability to exaltation of digestion organs
- the better digestibility of nitrogen of milk compared to nitrogen in other products

Digestibility of milk and milk products vary from 95 up to 98%. These products are easily digested, have high nutritional advantages and have antibiotic, medical and dietary properties. Sour-milk products are highly valuable because lactic acid stimulates digestive activity of the stomach.

1. Properties of Fermented Products

The fermentation product of the camel milk – **shubat** is extremely valuable and important product for human consumption. In Kazakhstan where the camel breeding is well advanced, processing of such fermented products is an old tradition. The microbiological processes in the camel milk for shubat preparation influence its physicochemical properties. In a fermentation process in shubat, the density, the dry matter quantity and the content of lactose decrease, the lactic acid level increases contributing to the acidity increasing. The fermented milk includes alcohol and carbonic gas also. The quantity of vitamins B_1 is changing and also vitamin B_2 increases 2 times, the high content of vitamin C (67,7 mg / ½) is conserved [10].

By its chemical composition and digestibility, shubat can be considered as valuable high energy nutritive product; therefore it can be used as good fortifying and tonic. It is effective at treatment of chronic diseases of a digestive organs, gastritis, peptic ulcer, liver disorders, and enteritis. For the patients the health status is improved, pains will disappear, appetite increases, secretary function of a stomach is normalized [7].

2. The Role of Lactic Bacteria

Despite of high nutritive and therapeutic value, the microbiology of the camel milk and shubat is extremely weakly investigated. A *kumiss* and shubat and also *kurunga* and *kefir*, - are mixed fermented products including lactic and alcoholic fermentation. In the microflora of such beverages, lactic bacteria and yeast dominate. The ability of lactic bacteria is to produce lactic acid. Lactic bacteria are non motile, do not form spores catalase negative, are Gram positive, do not form a pigment, do not change nitrates into nitrites. However, some authors have described strains which on some properties differ from typical. They are mobile, change nitrates into nitrites, form spores, and are catalase positive [10].

Lactic bacteria include genus *Lactobacillus, Leuconostac, Streptococus and Pediococcus* (Table 1).

Genus *Lactobacillus* combines rhomboid bacteria among which there is a homo and heteroferment types [12]. A product of fermentation is D(-) lactic acid (*Lactobacillus bulgaricus*) and DL lactic acid (*L. acidophilus*). Especially *Bacillus bulgaricus* and *B. acidophilus* have ability to produce antibiotic substances suppressing the development of intestinal microflora. *Bacillus acidophilus* presents a high resistance to adverse conditions of external environment in comparison to *Bacillus bulgaricus. B. acidophilus* growth at pH 8,0, in presence of medium including 20 % of gall, 2 % NaCl and phenol. Those properties can increase the spectrum of utilization of fermented products.

Genus *Leuconostac* combines heterofermentative coccus of the bacteria having oval or ovoid forms. *Leuconostac* produces at the time of the glucose fermentation process, form D (-) lactic acid.

Genus *Streptococcus* combines the homofermentative bacteria of orbicular or oval form sharing in one plane making couples or chains.

Table 1. Main products of fermentation [5].

D (-): dextrogyre; L(+): levogyre

Genus, subgenus	Type of fermentation	Main products	Profile of lactic acid
Lactobacillus			
Thermobacterium	homoferment	Lactate	D (-), L (+), DL
Streptobacterium	homoferment	Lactate/ acetate 1/1	D (-), L (+), DL
Betabacterium	homoferment	Lactate/acetate/CO_2 1 / 1 / 1	DL
Leuconostoc,	heteroferment	Lactate/acetate/CO_2 1 / 1 / 1	D (-)
Pediococcus	homoferment	Lactate	D (-), L (+)
Lactococcus.	homoferment	Lactate	L (+)

Table 2. Biochemical parameters of shubat.

Conservation lenth (in days)	Temperature, °C	Acidity °T	Volatile acids meq/l	Alcohol %	Diacyl, mg /100ml	Sugar %
1	18-20	116	11	0,8	0,01	4,40
2	18-28	210	36	0,9	0,05	2,29
	4-6	138	16	0,9	0,01	3,72
3	18-20	288	15	1,0	0,02	1,79
	4-6	152	12	1,0	0,01	3,02

Genus *Pediococcus* combines homofermentative coccus bacteria, cell fission is in two planes and as a result formed in grapes. The orbicular or oval forms share in one plane making couples or chains.

Shigayeva and Ospanova [10] have isolated from shubat two species of lactic bacteria *L. casei, S. thermophilus* which show following biochemical parameters (table 2).

The acidity increases as early as the second day. Thus, the quantities of sugar, volatile acids and diacetyl are decreasing. In three-day shubat, the acidity increases more strongly as well as volatile acids.

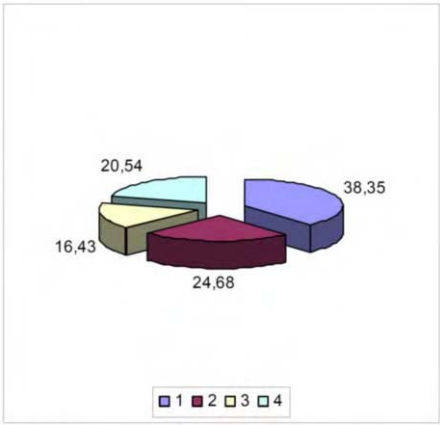
At temperature 4-6°C biochemical processes proceeds slowly. The level of diacetyl within three days remaining constant, aroma and taste of the beverage is maintained. Concentration of volatile acids for the third day becomes less. Alcohol production in shubat at storage temperatures 18-20°C and 4-6°C is identical and does not depend of the acidity.

The repartition of lactobacilli species in shubat vary according to the regions of Kazakhstan (Fig. 1A and 1B) indicating a variety of process for shubat making [11].

Samples of shubat from Atyrau region are the richest in *L. bulgaricus* (38,35 % of the colonies). The lowest concentration of *L. bulgaricus* is observed in shubat samples from Almaty region. At reverse, in those former samples, the number of *Lactobacillus casei* colonies is higher than in Atyrau region. *Lactobacillus brevis* culture has been observed in shubat from Atyrau only. From 100 isolates observed in Atyrau region, 73 include *Lactobacillus bulgaricus,* 26 *Lactobacillus casei*, and only one *Lactobacillus brevis*.

Aussel, (2) has isolated from shubat the following types: *Lactobacillus casei, Lactobacillus lactis, Leuconostoc lactis, Lactobacillus plantarum* and has investigated fermentation products obtained from different strains (table 3).

From after those data, it is important to know fermentation ways insured by the different strains of lactic bacteria for processing shubat. Shubat processing with heterofermented lac-



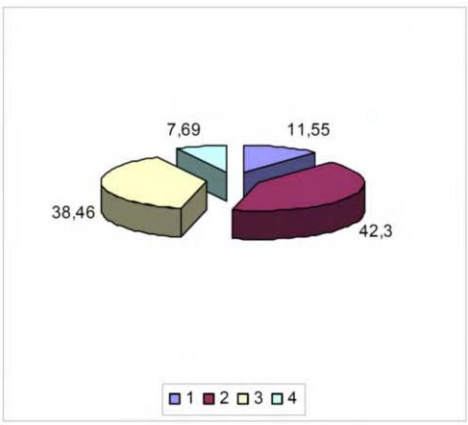


Figure 1. Repartition (in %) of Lactobaccili colonies in shubat from different regions in Kazakhstan. **Fig.1A.** *Lactobacillus bulgaricus.* **Fig.1B.** *Lactobacillus casei*, *Lactobacillus brevis.* 1 – Atyrau region, 2 – Aktyubinsk region, 3 - Almaty region, 4 – Kzyl-Orda region.

Table 3. composition of the fermentation products obtained by different strains of lactic bacteria (2).

Strain	Lactose	Lactate (g/l)	Acetate (g/l)	Ethanol (g/l)	pH	Bacteria
Milk	45.4	-	-	-	6.2	-
S1	33.4	11.0	0.9	0.4	3.69	Lacto. casei
S2	36.4	6.5	1.0	0.8	4.17	Leuco. lactis
S3	34.1	5.5	1.2	1.4	4.55	Lacto. lactis
S4	30.2	7.5	1.0	1.8	4.6	Lacto. lactis
S5	38.0	5.6	1.6	0.3	4.46	Leuco. lactis
S6	34.8	9.6	0.95	-	3.85	Lacto. plantarum
S7	34.9	9.5	1.2	0.6	4.0	Lacto. plantarum
S8	34.1	9.8	1.0	0.3	3.86	Lacto. casei

tic bacteria allows getting less sour, foamy product thanks to a high secretion of carbonic gas and little bit less alcohol.

3. The probiotic effect of shubat

Probiotiques are living microorganisms or products fermented by them which have positive influence on human health by normalization of the microecological status in digestive tract and stimulation of the immune system [6,9]. Lactic bacteria are probiotiques with effect on the conditions for development and resistance of intestinal microflora face to the deleterious effect of antibiotics on a normal microflora [1]. The basic problem in the last decades is the diffusion of antibioresistant forms of pathogenic microorganism and the decreasing of some antibiotics efficacy. So, one of the important probiotic activities is the ability to increase anti-infectious resistance of an organism, to give in some cases anti-allergic action, to control and stimulate digestion [8]. Reverse to the risk of antibioresistance of conditional or pathogenic agents, the lactic bacteria could be antagonist to those agents without developing resistance [11]. Face to polyantibioresistance, the control of infectious diseases, which represent 70% of all diseases [3], could be supported partly with the medical and prophylactic purpose of *Lactobacillus sp.* and their metabolites. These microorganisms are

probiotic effect in the gastrointestinal tract and are innocuous for the human health. Use of *Lactobacillus sp.* could be envisaged not only for treatment of gastrointestinal diseases, but also for other infection contaminations [4].

The high pH of shubat could be considered as a favorable media for the long term survival of probiotic bacteria. However, this survival could be less efficient in fermented milk product as shubat than in some cheese or yoghurt [6].

Conclusion

Shubat is a natural way of fermentation of camel milk. It is possible now to manage fermentation process by using specific strains of lactic bacteria and to increase the probiotic activity of this product. The modern dairy industry in Kazakhstan using traditional milk from camel must be able to propose new products for urban consumers, notably shubat with specific taste and composition associated with health factor.

References

[1] **Aleshin V.A., 2003.** Probiotic microorganisms – a modern condition of a question and prospect utilization. Dairy industry n°1, 59-61.
[2] **Aussel X., 2002.** Etudes des bacteries lactiques isolées du shubat et du koumis. Mémoire de BTSA Industrie agro-alimentaire, CIRAD, Montpellier, France, 51 p.
[3] **Bondarenko V.M., 1999.** Factors of pathogenicity and their role in development of contagious process. Microbiology n° 5, 34-39.
[4] **Gavrilova N.N. *et al.*, 2002.** Prospects of utilization of *lactobacillus* in medicine and a veterinary science. Vestnik Kaznu, serie Biology n°1 (16), 18-21.
[5] **Kandler, 1982.** *Lactobacillus teuferi*. Int. J. Syst. Bacteriol., 32, 266.
[6] **Roy D., 2002.** Les bénéfices du vivant : Les fromages. Les probiotiques dans le fromage. CONGRILAIT, Proc. 26th IDF World Dairy Congress, 24-27 sept. 2002, Paris (France), n°35, 13 p.
[7] **Sharmanov T.S., Gangabilov A. K., 1981.** The Basic alimentary components, biological and alimentary value of national milk food., Almaty Publ., p.22.
[8] **Shenderov B.A., 1988.** Medical microbial ecology and the functional feed. Almaty Publ. 35 p.
[9] **Sheveleva S.A., 1999.** Probiotiques, prebiotiques and probiotic products. Voprosi Pitaniya, n°2, 23-27.
[10] **Shigaeva M., Ospanova M., 1983.** Microflore des produits laitiers fermentés traditionnels. Publ. Nauka, Alma-Ata, 147 p.
[11] **Tokabasova A.K., 2003.** The autoabstract: « the lactate flora shubat various ranges of Kazakhstan » PhD dissertation, Al-Farabi Kazakh National University, Biological faculty, Almaty.
[12] **Tulemisova Z.K., 2002.** Lactic acid bacteria and their phases. Almaty Publ. 187 p.

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The Effectiveness of the People Treatment with Camel *Chal*

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Abstract. In ancient times, Turkmenians use camel milk for the preparation of sour-milk product – *chal*. For the first time, it was used for treating for diseases of the gastrointestinal tract 50 years ago. The conducted experimental investigations showed that *chal* has expressed bacteriostatic and bactericidal properties with effect to the pathogenic bacteria of intestinal group. According to clinical studies, the treatment with *chal* is followed by an improvement in the general health. The disappearance of the signs of disease was observed in patients with the secretory insufficiency and the normal acidity of gastric juice and their improvement - in patients with the increased acidity. There were disappeared or decreased the signs of the bowels activity breakdown. The *chal* application does not cause changes in the absence of free hydrochloric acid and normal acidity of gastric juice. Prolonged use of chal (15-20 days) facilitates the normalization of the pancreas extra-secretory activity in patients with the diseases of gastrointestinal tract. The prolonged *chal* application has the normalizing effect on the enterokinase production in the small bowels and restores the processes of the ferments inactivation in the large bowels in the patients with chronic gastritis and chronic colitis.

The *chal* can be recommended for the preventive maintenance of bowels dysbacteriosis of together with the antibiotics application.

In ancient times Turkmens use camel milk for the preparation of sour-milk product –*chal*. For the first time, it was used for treating diseases of the gastrointestinal tract, 50 years ago. The pioneer of *chal*-therapy is Khodzhakuliyev G.K., who in 1953 proposed to use it as dietetic and therapeutic product. The conducted experimental investigations showed that *chal* has expressed bacteriostatic and bactericidal properties with effect to the pathogenic bacteria of intestinal group (typhoid and paratyphoid, dysentery and enteropathogenic coliform bacteria). Moreover the antibiotic action of *chal* is manifested after 2 hours. In the same study there was proved the *chal* ability to stimulate gastric juice with the large digesting ability and acidity, and its rapid evacuation from the stomach into the bowels.

Some clinical studies of Khodzhakuliyev G.K. were carried out on 160 patients with chronic gastritis in combination with a liver function and bowel activity breakdown receiving the treatment with *chal* (medicinal therapy was not assigned). There was noted an improvement in the general health and a decrease or the disappearance of the subjective and objective symptoms, existing prior to the treatment beginning.

The disappearance of the signs of disease was observed in patients with a secretory insufficiency and a normal acidity of gastric juice, and their improvement – in patients with an increased acidity. There were disappeared or decreased the signs of the bowels activity breakdown, cholecystopathy, hypovitaminosis and anemia, normalized or decreased the liver dimensions (if it was increased before the treatment). The side-line phenomena caused by *chal* application were not observed. Patients increase in weight upto1-3 kg. At the low-

ered gastric juice acidity, the secretory indices of stomach after the course of *chal* treatment are risen, moreover in the most of patients - to standard. An increase in the secretory indices was noted also in patients with the increased gastric juice acidity.

The *chal* application does not cause changes in the absence of free hydrochloric acid and normal acidity of gastric juice. The evacuation function of stomach changes to the normalization (retarded function is accelerated, and acceleration slows down), moreover in the predominant majority of patients, independent of the gastric juice acidity it comes to the standard.

According to morphological data at the absence or with the moderately expressed atrophic changes in the mucous membrane of stomach there were observed the decrease of the inflammatory infiltration of stroma and an increase in the secretory activity of the gland apparatus. At the neglected atrophic processes there were noted only the intensification of plasma-cell reaction and formation in the mucous membrane of lymphoid follicles in the stomach.

Prolonged use of *chal* (15-20 days) facilitates the normalization of the pancreas extra-secretory activity in patients with the diseases of gastrointestinal tract, especially in the patients with chronic gastritis with the secretory insufficiency.

At the same time the pancreas intra-secretory function was improved. The prolonged *chal* application has a normalizing effect on the enterokinase production in the small bowels and restores the processes of the ferments inactivation in the large bowels in the patients with chronic gastritis and chronic colitis. Treatment with biomycin causes an increase in the content of intestinal ferments in the feces; the *chal* application together with biomycin does not disrupt the bowels fermentative function.

The *chal* can be recommended for the preventive maintenance of bowels dysbacteriosis together with the antibiotics application.

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Development of Products for Child Nutrition and for Medical and Prevention Purposes on the Base of Camel Milk

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Abstract. The sour-milk product "Akbota" on the basis of camel milk fermented by special selected culture of lactic bacteria and high biochemical activity, rich with vitamin E, folic acid, iron and selenium was developed in view of chemical compound, nutrient and biological value of camel milk, and also typical for the population of the Republic of Kazakhstan micronutrient deficiencies.

On the classical model of activation of free radical processes (injection of CCl_4) the antioxidant and immunomodulatory properties of product were established. It was demonstrated, that the use of products by animals is resulted to reduction of final products of peroxide oxidation of lipids in rat's blood, to renewal of fermentative and non fermentative section of antioxidant protection.

Thus the level of vitamins in condition of toxically injection by CCl_4 is increased on 48,6; 30,2 and 29,0 percents on the case of product, and the reliable lowering glutation peroxidase and glutation reductase activities are increased on 48,0 и 56,2 percents accordingly. Opposite, the catalaze and superoxid dismutase activities in condition of toxically injection by CCl_4 are increased on 45, 6 and 56,0 percents in the case of using special product. The microbiocenosis normalizing and antianemic action of product were established on the group of patients with disbiotical weaks.

After the treatment course with using sour-milk product, the frequency of disbiotical disturbances of intestines of 3-d degree is reduced in three times. A frequency of deficiency of Bifidobacterium and lactobacterium is reduced in patients with first level of dysbacteriosis, and a level of enterobacterium is became normal.

The biological characteristics of Escherichia coli are restored; a seeding of autoflora with hemolytic and lactose-negative characteristic is stopped. Reception of product was accompanied by sanational properties concerning to thick intestines.

Alongside with microbiocenose normalized effect of the product the potentially immunnocorrected its action has been shown in model experiments.

Antianemic effect of the product was shown in increasing of level of haemoglobin, erythrocytes, serum iron in blood of surveyed patients.

Thus, the new sour-milk product with directed to pluripotent properties on the basis of camel milk with inclusion of a complex of biologically active substances is created.

Introduction

Comparison of chemical composition of female and camel milk on such important micronutrients as vitamins and microcells, and also taking into account daily requirement of an

Table 1. Content of product "Akbota" (per 100 kg without losses).

The name of raw material	Norm
Milk camel, fat content less than 3,2 %, kg	
The ferment prepared on the base of cow	92.5
milk, kg	5.02
Sugar, kg	2.04
Iron lactic, g	0.5
Cu, g	0.12
Zinc, g	0.12
Selenite of sodium, g	0.01
K iodid, g	0.02
Vitamins, gr.	
Bc	0.004
E	1.5
Potable water drinking, kg	0.44
TOTAL:	100.0

organism of child in the age of 6 months to 1 year of age in major factors of feed has allowed to come to the following conclusions:

Camel milk is scarce on a lot of vitamins, such as a folic acid, vitamin E, D. In case of use of camel milk as supplement feeding the daily need for the basic micronutrients using 500 ml of milk is satisfied regarding vitamins B6, B1 and C on 65, 52 and 60 % accordingly.

Camel milk imbalance in relation of level of iodine, iron, zinc and selenium.

Taking into account high rate of iron deficiency anemia and Iodine deficiency conditions among various age groups of the population of the Central Asian region, fortification of products by micronutrients represents certain interest at designing both child nutrition products and products for preventive and treatment purposes on the basis of camel milk.

The Development of Sour-Milk Product

Connecting to this, we develop technology of preparation of sour-milk product "Akbota". Alongside with normalization of product regarding fatty component (3,3-3,5 % of fat) in addition the product was fortified with iron, iodine, selenium, zinc, vitamin E and folic acid.

Content of product "Akbota" is given in Table 1.

Apparently from Table 1, compounding of the product alongside with camel milk, complex of microcells and vitamins, includes sugar, allowing not only to increase caloric content of the product but also to give to it the certain flavoring characteristics.

Association of lactic bacteria (*Lactobacillus acidophilus* strains 630 and 97, *Streptococcus lactis*, *Lactobacillus casei*) was used as ferment.

Apparently from the data submitted in Table 2 the product contains a complex of vitamins and microcells alongside with fibers, fats and carbohydrates. Caloric content of the product lays within the limits of 61.4-62.5 kcal per 100 ml of the product.

The product had good parameters. The period of storage of the product varies from 48 to 72.

Acidity of the product laid within the limits of 60-80 T.

Table 2. Chemical composition of sour-milk product “Akbota”.

Parameters	Content in the product
Water, g	89.01
Fiber, g	2.23
Fat, g	3.2-3.3
Carbohydrates, g	6.15
Vitamins, mg: B1	0.033
B2,	0.041
B6	0.052
Bc	0.004
PP	0.4
C	3.6-4.0
A	0.06-0.07
E	0.1-0.15
Microcells, mg:	
K	66.0
Na	50.0
Ca	97.0
Mg	14.0
P	50
Fe	0.20
Mn	2.9
Cu	0.12
Zn	0.12
Se	0.01
I	0.02

Energy value of the product _____ 61.4-62.5 kcal per 100 g

The Biological Effect of Sour-Milk Product

In the subsequent biochemical properties of product “Akbota” as in experiment, and natural supervision were appreciated.

On classical model of activation of POL processes, when poisoning of rats by CCl4 it was shown, that daily reception of a product by animals was accompanied by authentic decrease in blood and fabrics of processes of lipids oxidation.

A priming by four-chloride carbon it was carried out by intragastric introduction of solution CC14 in olive oil in a doze of 0,1 ml/100 g weights of a body within 30 days.

At 30-day's reception of a sour-milk product on a background of toxic priming CCL4 in a liver of rats speed of accumulation of aldegid with 0,75±0,06 up to 0,45±0,04 mg of fiber of mines, and also the contents of the bases with 4800±350,0 up to 3500±230,6 mg of fiber in one minutes was reduced. Confirmation of increase of the status of animals on a background of reception of a product was also increase in blood of rats of a level of vitamins And, E and With on 48,6, 30,2 and 29% accordingly.

Normalization of activity of enzymes of antioxidant systems and approximation of their values control sizes was marked also.

So, on a background of a priming four-chloride carbon in a liver of rats reveals decrease of activity glutathion peroxidase on 56,2% and glutathion peroxidase on 48,0%. On the contrary, activity catalase and peroxidestimulase on a background of a priming four-chloride carbon has increased by 45, 6 and 56,0% accordingly.

Monthly consumption of a sour-milk product on the basis of the camel milk has resulted in normalization fermentative link antioxidant system.

In particular activity glutathion peroxidase and catalase has increased, peroxide stimulase and catalase has decreased also their values have come nearer to initial sizes.

The received data testifying about expressed antioxidant effect of a product could be connected directly to its chemical compound the increased level in a product of vitamins - antioxidant (And, E, C), lipids, polyunsaturated fat acids, the selenium, membranes determining structurally functional integrity and lowering processes lipid oxidation in an organism.

Proceeding from structure of a product, presence antioxidant effect, quite assumed possible immunocorrective properties.

From the received data it is visible, that the priming was accompanied by four-chloride carbon statistically significant reduction of abilities of rats to develop the initial immune answer on erythrocytes the ram, i.e. Æ-dependent immune reaction.

The level of antitel cells was reduced. On a background of a product authentically less expressed decrease of parameters AOK was marked, i.e. the protective effect of a product in the attitude immunosuppressive effect of four-chloride carbon on such integrated parameter immunology competence, as quantity AOK was shown at the initial immune answer on erythrocytes the ram.

Immunoprotective action of a sour-milk product was established and on dynamics of synthesis of specific antibodies in reaction of a straight lines haemoglutination to erythrocytes the ram.

I.e. the product rendered protective action in the relation of formation of immunodeficiency on parameters of intensity of formation of the initial immune answer to the Æ-dependent antigen (credits specific haemoglutin in whey of blood and quantity of AOK in a spleen).

Immune response modifier effect of a product was connected to a high credit of lactic bacteria, presence in a product microbic liposacharids, having powerful Immunostimulate action, and also presence of vitamins - antioxidants, with - 6 fat acids participating in regulation of immunity.

Alongside with antioxidant effect the sour-milk product had antianemic action. First of all it concerned increase in blood of animals on a background of consumption of a product at priming CCl4 of a level erythrocytes, hemoglobin, serum iron and ferritin by 18.0 and 22,0%, and 36 and 38% accordingly.

Presence antianemic effect at a product was connected to its favorable action on processes haemopoesis, and also transport, absorption and recycling of iron in an organism, due to presence at a product of a folic acid, vitamin With and the organic acids being absorption promoter of iron.

The General Effect on Health and Growth Status of Child

Efficiency of sour-milk product “Akbota” was appreciated on children who are taking place on artificial feeding in the age of from 6 months till 1 year, observed in a children's polyclinic and living in conditions of the house - child.

During supervision the general condition of children, appetites, integuments were taken into account, were estimated weight and height parameters, and also some biochemical parameters of blood describing a level of security of an organism by iron (content of hemoglobin, serum iron and ferritin). Term of supervision has made 6 weeks.

As have shown results of the carried out clinical supervision, children transferred sour-milk mix “Akbota” well, any indigestion phenomena, and also refusals of the use of a product was not revealed.

The sour-milk products, observably children received in parallel with entered supplementary feeding.

The daily average increase of weight of a body at receiving sour-milk mix “Akbota” statistically significantly did not differ from those at children who are taking place on chest

feeding (27,0+1,2 g/day and 28,0+2,2 g/day accordingly) and was higher than the same parameter determined at children, receiving a sour-milk product on the basis of cow milk "Aruana" (20,3+0,6 g/day). Were higher as well parameters of a weekly gain of length of a body at accepting a sour-milk mix on the basis of the camel milk, than at a product on the basis of the cow milk (0,54+0,05 and 0,43+0,04 sm. accordingly).

The received results testify that sour-milk product "Akbota", in comparison with supplementary feeding on the basis of the cow milk, promotes the best physical development of children who are taking place on artificial feeding, and is more adequate food for children of early age.

Feeding by a product within 6 weeks resulted in increase in their blood of a level of hemoglobin, erythrocytes, contents of iron and ferritin.

Higher antianemic the effect of mix "Akbota", in comparison with "Aruana", naturally, is caused by advantages on biological and food value of the camel milk, than cow. The last, first of all, is connected with their albuminous and fat - acid structures, a level of an ascorbic acid, folate, vitamin E, selenium, iodine, iron and other biologically active connections participating in maintenance of bioavailability of iron, formation of its stocks and processes of haemopoesis.

Thus, the received data testify that in part adapted sour-milk product "Akbota", can be used in quality - supplementary feeding for feeding children of early age since 6 months and is more senior, taking place on artificial and mixed feeding, and also as a medical product for preventive maintenance and treatment Iron Deficiency conditions of an easy degree of weight.

The Effect on Internal Microorganisms

We also executed special research on studying an opportunity of correction broken biocenosis intestines with the help sour-milk supplementary feeding "Akbota". Under supervision were persons in the age of 18-40 years with the diagnosis disbacteriosis intestines.

The standard basic therapy was carried out on a background 30 daily reception ' on 500ml of a sour-milk product on the basis of the camel milk, and control (accepting on the similar circuit a product on the basis of the cow milk - "Aruana").

Microbiological researches of fecal carried out in the beginning of treatment, is direct after its termination and in anamnesis (in 8-12 months).

The analysis of microbiological researches has shown that at all surveyed was registered to some extent expressed disbacteriosis intestines.

Already directly after the carried out course of treatment with use of sour-milk products approximately in 3 times in both groups frequency of revealing microbiological infringements of intestines of 3 degrees (in skilled group from 27,2% up to 9,1% has decreased; in control - from 16,8% up to 5,3%), thus the share of patients with the first degree of disbacteriosis, both in skilled, and in control groups has essentially increased (in 2,5 and 1,8 times accordingly).

In sample group of the patients receiving a sour-milk product on the basis of the camel milk, it was marked expressed effect concerning the revealed infringements of intestine biocenosis. In particular, it was essentially reduced frequency of deficiency of representatives of protective microflora (bifidium- and lactobacteria), it was normalized the content of E*nterobacteria*, decreased their initially high presence, frequency of their revealing was reduced up to 40%. Biological properties of intestinal sticks were in parallel restored, sowing flora with hemolitical and lactosanegative properties has stopped. Reception of product "Akbota" also was accompanied by pumping effect concerning conditional - pathogenic microflora of thick intestines. In particular, bacteria *Proteus* and yeast-like fungi of

Candida genus disappeared. In relation to *coccus* microflorae in sample group also were marked positive shifts on a background of reception of a product which was shown in increase of average values of the E*nterococcus* content, reduction of frequency of revealing of their low amount and sharp reduction of cases of presence *Staphylococcus aureus*.

Thus, the new sour-milk product with directed polypotential properties was created on the basis of the camel milk, with adding a complex of biologically active substances.

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Camel Milk Production and Transformation in Sub-Saharan Africa

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Abstract. Camel herders attribute many properties for camel milk, including medicinal or health effects. In fact, Camel milk is also used in the treatment of diabetes, liver diseases, general fatigue in old people and as a feed supplement to milking mothers. Camel milk yield varies from 650 to 12000 liters per lactation with a mean of 2500 liters. In dry areas, milk yield fluctuates considerably from time of abundance to time of acute scarcity according to the availability of grazing and feed supply. Thus, transformation of the surplus of milk to cheese will allow for fighting under nutrition and could constitute an income for herders.

The camel's milk is also known for its antimicrobial activity which is confirmed by its late acidification and good stability. This activity is more important in whey than in casein and is related to the high level of lactoferrin, lactoperoxidase and lysozymes which varies from 280 to 648 mg/l vs. 13 mg/l in cow's milk. The spontaneous acidification and clotting of raw milk at 35 °C is longer in camel's milk with a latent phase ranging from 4 to 8 hours vs. 2 to 3 hours for cow's milk. Enzymatic coagulation of camel's milk is also difficult and known by herders who increase the rennet adjunction by 50 to 100 times than that used in the other ruminant milk. The lower coagulation of camel's milk could be explained by its poorness in casein 6, the bigger size of micelles, the lower dry matter content, the smaller size fat's globules and the low content of colloidal calcium which is 35% vs. 65% in cow's milk.

The extreme fragility of camel's milk curd is responsible for the lost of a major part of dry matter in the whey. From the total dry matter of milk, camel's milk curds contain only 30% vs. 50% in cow's milk and 68% in sheep milk.

The camel's cheese taste is slightly bitter with no specific flavor, its texture is medium.

Many types of camel cheese are made in some countries in intensive production systems. Cheese making is also possible from camel's milk by nomadic herders. Further studies are necessary to improve camel milk production and transformations with new methods and adapted to nomadic herders and their lifestyle.

Keywords. Camel, milk, cheese

Introduction

Among domestic ruminants, the dromedary camel is a species which survives and produces in high air temperature despite the lack of drinking water and feed supply as result of physiological and behavioural adaptation. In fact the camel and its productions provide for the survival of herders in dry areas. Besides its contribution in traction, transports (cara-

vanning), and agricultural work for more than 5000 years, camel produces meat, milk, hair and leather.

More than 60% of the world's agricultural land is not arable and is reserved to grazing and animal production. The majority of these lands is arid or semi arid. In order to provide for the alimentary lack in the world, the improvement of animal production in these areas is the way to stabilize nomadic herders and constitutes a key element in socio-economic development of these countries [8].

Camel herders, look at the camel as a gift of the sky, as anointing animal which is necessary to their survival, trade and travel. Its milk is the base of their nutrition, its meat is much appreciated and its hair, renewed every year by moulting is used for tents and cloth fabrication. The camel milk is important and in some times the only nutrient for nomadic people. However, the seasonality of milk production induces a lack of milk during the dry season and an excess during the rainy season. Thus, milk transformation to cheese is a precious nutritional source to fight under-nutrition during the dry season. Producing camel cheese is not an easy task because of the difficulty of coagulating milk. The purpose of this review is to present the milk production, composition and transformation in subsaharian countries.

1. Camel Populations in the World

The statistics on camel numbers are difficult to ascertain because of the lack of reliable informations in dry areas concerning nomadic herders. The camel population is estimated to more than 20 millions in the world. This number is in continuous development in many countries in Africa which counts for more than 80% of camel populations. In fact, the camel number in the world increases annually by a mean of 0.4%. This increase could be related to the progression of dryness in Africa where some nomadic people (Peulhs in West Africa or Borana in East Africa) mate over cattle and replace them by camels.

Camel density varies from 1 camel per 50 km^2 in (Burkina-Faso, Iran, Turkey) to 1 animal per km^2 in (Kenya, Djibouti, Ethiopia, Sudan, Tunisia, Pakistan, United Arab Emirates); the maximum being observed in Somalia with more than 10 camels per km^2. However, density per country does not reflect the real distribution because camel are concentrated in dry areas in each country. As an example in India, more than 80% of camel population is located in Rajasthan. Reported to human population, one can count 1 camel for 20 people in the countries of Africa and 1 for 350 people in 17 countries of Asia. In Somalia, this figure arises to 2 camels per person [8].

In many countries, camel has important socio-cultural roles. For example, In Somalia camel exportation is the first source of currencies for the country. Milk for human consumption is provided by camel and more than 80% of breeders sell camel milk. In Mauritania and south of Morocco, camel milk commercialisation is important for cities supplying in milk. Moreover, camel milk is more appreciated than cow milk. For example, in Morocco, the price of camel milk is 3 times higher than the one of cow milk [7].

2. Camel Milk Yield

The estimation of milk yield potential of dairy camels is very difficult because of the variety of techniques used in measurements including or not the quantity suckled but the young camel. In fact the presence of calf with its dam during the day increases milk yields. Milk yields can decrease by 65% if calf is loosen. The major factors that affect camel milk yields include the forage (quality and quantity), watering frequency, climate, breed, age and par-

ity, milking frequency, calf survival and the presence of calf, milking method, speed of milking, health status, reproductive status and individual potential [3].

As for cow, camel has an udder with 4 quarters not clearly separated. Teats are not as long and have 2, 3 or 4 orifices. This peculiarity does not permit a local treatment of mastitis. The milk storage in the mammary gland is not internal but alveolar that explain the difficulty of milk ejection with out the calf. The posterior quarters are bigger than the anterior. Female camels are generally milked twice a day, in the morning and in the evening. In some intensive systems, they are milked up to 3 or 4 times. The increase in milking frequency from 2 to 4 times induces an increase in milk yield by 12% [25]. In some countries, ocytocin is used to increase milk yield. The great variability in shape and size of udder and teats does not allow a large scale use of milking machines for camels. However, in some countries milking machines are adapted to well-formed udders and teats.

Camel milk yield varies also according the breeds or types; Asian breeds produce more than African ones. Milk yield varies from 650 to 12000 litres per lactation (10-12 months) [28] with a mean of 2500 litres. The daily production varies from 6 to more than 26 litres and the mean varies from 6 to 14 litres [9]. Knoess *et al.* [13] showed that camel can produce a milk volume ranging from 17 to 26 litres daily; these volumes remain often unchanged or only slightly lowered after one year.

The milk curve of female camels is comparable to the one observed in cows; the peak of lactation is recorded 2 to 3 months after calving. The persistence coefficient which relate to produced quantity in the next month (m+1) compared to the one of the last month (m) is higher than 80% in many studies. Under the same climatic conditions, camels produce generally more than cows [13]. The lactation duration vary from 6 to 18 months according to the breeding systems, the availability of grazing and the time of the last calving [8].

3. Camel Milk Therapeutic Properties

Camel herders attribute many properties for camel milk, including medicinal or health effects. In the south of Morocco and other countries camel milk is used to treat diabetes. In fact, camel milk contains 40 insulin units/l and the low coagulation of camel milk in the stomach decreases insulin destroying. This hypoglycaemic effect was confirmed in rabbit receiving camel milk. Camel milk is also used in the treatment of liver diseases, general fatigue in old people and as a feed supplement to milking mothers [28].

4. Camel Milk Composition

Results concerning camel milk analysis are sparse and vary according to the breed, the stage of lactation, watering frequency, feed supply and the technique of measurement. The titratable acidity is slightly higher than the one observed in cow milk and the pH varies from 6.55 to 6.65 [5]. The density that is correlated to the dry matter contents varies from 1.0240 to 1.0337. The cryoscopic point is around -0.576°C [24].

The chemical composition of camel's milk is comparable to the one in others domestic species [2]. Camel's milk composition ranges from 85 to 88% of water, 8 to15% of dry matter, 3.4 to 5.6% of lactose, 2.5 to 6.2% of fats, 3.5 to 4.5% of crude proteins and 0.7 to 0.95% of minerals. The water deprivation induces an increase of water contents and does not affect the daily production. However, the peculiarity of camel's milk is its richness in vitamin C which gives the milk its sweet taste often masked if animals eat salty or bitter vegetation [28]. The fat composition of camel's milk differs from that in cows. It is richer in unsaturated fatty acids [6]. Crude protein levels are lower than the one observed in

cow's milk 4.07 ± 0.28 mg/ml *vs.* 5.16 ± 0.08 mg/ml [18]. Non protein nitrogen contents of camel's milk is higher than the one in cow's milk which can be related to the higher concentration of amino-acids in camel's milk (46.5 :M/100ml *vs.* 28.8 :M/100ml). The casein contents expressed in % of crude proteins in camel's milk (64 – 77%) is lower than that of cow's milk (77 – 82%). The casein 6 that is responsible for milk coagulation by rennet enzymes is very low in camel's milk and represent 5% of total casein *vs.* 13% in cow's milk and its rate of sialic acid is higher (0.735% *vs.* 0.302%). In contrast, casein $\forall s_1$ and $\forall s_2$ are more concentrated in camel's milk than in cow's milk (63% *vs.* 46%). The mean camel's milk casein micelle size (280 – 321 nm) is double of that in cow's milk (140 – 180 nm) [6,12].

The camel's milk is also known for its antimicrobial activity which is confirmed by its late acidification and good stability. This activity is more important in whey than in casein [10] and is related to the high level of lactoferrin, lactoperoxidase and lysozyme which varies from 280 to 648 mg/l *vs.* 13 mg/l in cow's milk. The antimicrobial activity inhibits pathogenic bacteria multiplication. The antimicrobial activity increases camel milk conservation and safety, but reduces its acidification which hampers cheese fabrication [4].

5. Camel Milk Transformation

Pasteurisation and sterilisation of camel's milk is used in Mauritania and Saudi Arabia despite its low heat stability. However, phosphatase and peroxidase are not destroyed by pasteurisation and the measure of the activity of these enzymes is not valid for camel's milk pasteurisation control [16]. Other enzymes as leucine arylamidase has been tested in Mauritania [15] and gamma glutamyl transferase in Morocco [16]. Recombined powder and condensed camel's milk were also made in some trials.

Separation of cream requires 5-6 days under refrigeration and must be repeated to obtain good yields compared with several hours for cow's milk [1].

6. Camel Cheese Making

In Subsaharian countries, milk yield fluctuates considerably from time of abundance to time of acute scarcity. The rain season stretches from June to August and corresponds to an important availability of grazing and feed supply. During this period, camels are in good stoutness and the milk production is abundant. However, during the dry season which is much longer, the milk production is scarce. Thus, transformation of the surplus of milk to cheese will allow for fighting under nutrition and could constitute an income for herders. Although cow cheese processed according to the pastoral traditions in the desert is common, camel's milk transformation to cheese is sparse except in some tribes in the Sahel and Middle East regions. Cheese making includes many procedures in order to reduce the water activity and pH for which the balance is specific for each cheese type. Cheese fabrication includes three successive operations: coagulation, draining and maturation [23].

6.1. Coagulation

Lactic acidification and enzymatic or rennet activity are the two methods used for milk coagulation. The combination of these two actions is usually used and the part of each of them is characteristic of the type of cheese produced. The acidification is conducted by transformation of lactose to lactic acid by lactic bacteria normally present in the milk. Fermentation ability of camel's milk is lower than that observed in the other domestic rumi-

nants. The spontaneous acidification and clotting of raw milk at 35°C is longer in camel's milk with a latent phase ranging from 4 to 8 hours *vs.* 2 to 3 hours for cow's milk. This peculiarity is related to antimicrobial activity of camel milk and its richness in lysozyme, lactoperoxidase, vitamin C and its high power buffer properties compared to cow's milk [23]. The fermentation of camel's milk does not provide a veritable coagulum but a fleecy gel characterized by the presence of three layers; a very soft and particle like curd on the surface, a soft layer in the middle and a stronger one, like a curd in the bottom [11]. Enzymatic coagulation of camel's milk is also difficult and known by herders who increase the rennet adjunction by 50 to 100 times than that used in sheep, goats or cows milk. Under the same conditions, the clotting time is 2 to 4 times longer in camel's milk than cow's milk [23]. The inhibitory enzyme activity depends on the enzyme; the best activity was obtained with bovine pepsin. Calf rennet and *Mucor miehei* clotting protease have lower activities and chymosine and clotting protease of *Endothia parastica* have very lower activity [20]. However, the bovine pepsin which has the highest proteolysis activity catalyses also the hydrolysis of casein ∃ and releases some bitter peptides. This effect is accentuated when the pH of cheese is lower than 6. Thus, the use of bovine rennet and *Mucor miehei* clotting protease is more recommended [22]. The lower coagulation of camel's milk could be explained by its poorness in casein 6, the bigger size of micelles, the lower dry matter content, the smaller size fat's globules and the low content of colloidal calcium which is 35% *vs.* 65% in cows milk. The colloidal calcium level decreases significantly in dehydrated camels [27]. The low coagulation ability of camel's milk could be corrected by blending with other ruminant milks, or adding calcium or ferments.

6.2. Draining

The extreme fragility of camel's milk curd is responsible for the lost of a major part of dry matter in the whey. From the total dry matter of milk, camel's milk curds contain only 30% *vs.* 50% in cow's milk and 68% in sheep milk (Figure 1) [21]. The whey of camel's milk is rich in dry matter and fat which is 4 times than that in cow's whey for the same cheese. The colour of camel's lacto-serum milk is white whereas it is greenish for cow. This peculiarity could be related to its richness in fat and micelles and its poorness in riboflavin. Draining of camel's milk curds is fast and may be explained by its high water content and its low retention of water. The slow curd acidification during draining is related to the low fermentation of camel's milk [23].

6.3. Maturing

Few trials and observations on camel's milk cheeses processing and maturing are reported. Data concerning the physical and chemical characterization of camel's cheese are not available. The taste is slightly bitter with no specific flavour, its texture is medium but two defaults could be mentioned: first, its low oiliness caused by its low fat content and the low hydration of proteins, and second its sticky characteristic during mastication [23].

7. Traditional Camel's Milk Cheese "Tchoukou"

Nomadic herders in the Sub-Saharan African countries prepare cheese from cow's milk during the rainy season. This cheese made by women for whom its constitutes a source of currency and a food supply during the dry season is called *tchoukou* in *Haoussa* language or *tikomart* in *Tamachek* language [14]. It is a dry cheese made by rennet coagulation just

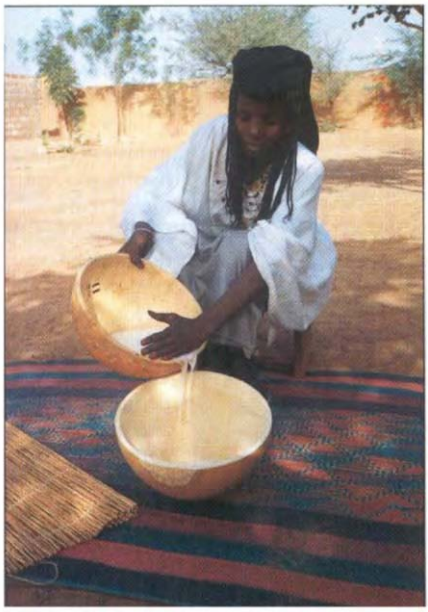

Figure 1. The curd is filtered manually and the whey is recuperated in an other calabash.

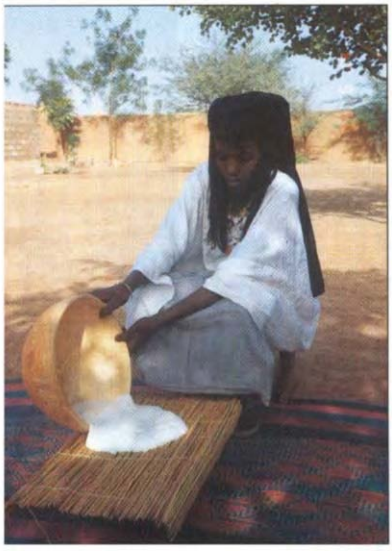

Figure 2. Curd is displayed on the Panicum mat over an other calabash.

after milking and drained rapidly because of its low thickness with no specific maturing technique. It is consumed in tea or in the millet gruel after grinding.

Camel's milk is usually drunk fresh or after a little fermentation. Camel's milk cheese processing was initiated by a FAO research project on improved processing methods which have leaded to the availability of stabilised ferments (starters) minerals and vegetable pro-

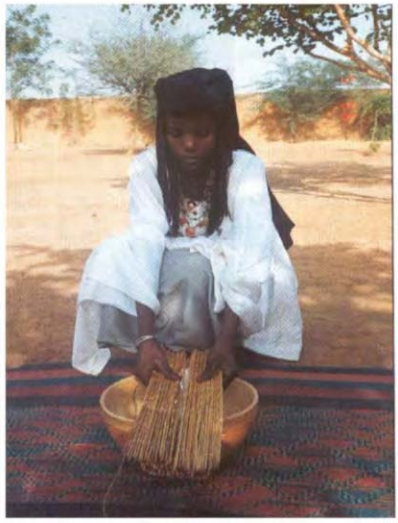

Figure 3. The curd is pressed between two mats in order to have a rectangular form.

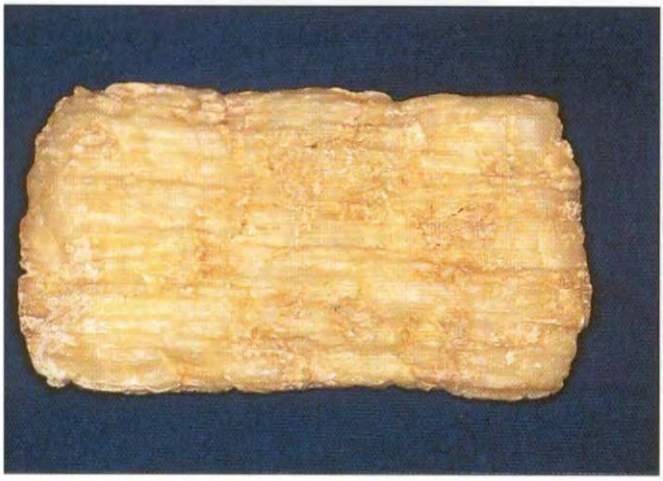

Figure 4. The Camel's *tchoukou*.

tease having homogeneous quality such as the camifloc®. The process is combining different activities: early and progressive acidification, correction of unbalanced mineral contents of camel's milk, coagulation with an adapted enzyme, and fermentation through use of lactic starters inoculum acting as acidifying agent with aromatic characteristics. These starters have been experienced in pastoral areas in Niger and have demonstrated a good ability to serve local practices in order to produce camel's *tchoukou* cheese. This traditional fabrication including the following operations needs calabash, glass, sifter, straw or *Panicum sp.* mat as materials.

One dose of the ferment (camifloc®) is dissolved in 30 ml of water in a tea glass and added to 2 litres of sifted milk which is stirred during 3 minutes, then the calabash is covered by a clean mat during 36 hours.

The curd is displayed on the *Panicum* mat over a calabash in order to recuperate whey. The curd is pressed between two mats in order to have a rectangular form. The cheese is dried on the sun for 48 hours and stored in a aired area.

Tchoukou composition includes 93.5% of dry matter, 55.1% of crud proteins, 30.5% of fat, 6% of ash, 1.67% of lactose, 0.14% of galactose, 0.06% of glucose, 0.02% of fructose and 0.01% of saccharose [19].

Camel's *tchoukou* is appreciated by nomadic people and preferred to cow's tchoukou. However, many problems are observed including:

- Standardisation of the technique and products: the form, colour and weight of cheese are extremely heterogeneous and its yield and component recovery is very low compared to cow's milk.
- Respect of ferment dose
- Cheese making during moving periods is disturbed
- Hygienic quality of *tchoukou* do not allows its export
- Its price doubles the cow's *tchoukou* but its production is expensive considering the price of camifloc®. Camel herders are tending to reduce the cost by blending camel's milk with cow's or goat's milk.

Conclusion

Camel's milk is distinguishable from other ruminant's milk by many physical, chemical, dietetic and therapeutic properties. It is rich in vitamin C, inhibitory factors, chloride but it is poor in dry matter, calcium and phosphorus. An important advance was made in the knowledge of physical and chemical characterisation of camel's milk, However, studies concerning the technology and processing of camel's milk transformation are sparse. Camel's milk ability to transformation is different from that in other domestic ruminants. Many types of camel cheese are made in some countries in intensive production systems. Cheese making is also possible from camel's milk by nomadic herders.

Further studies are necessary to improve camel milk transformations with new methods and adapted to nomadic herders and their lifestyle. Others studies concerning its therapeutic and dietetic properties will clarify this enigma. Such research will improve the camel milk production and well being of camel herders. The standardization of recording method and the study of the genetic potential will allow the identification of dairy breeds before any subsequent selection. The use of some new biotechnological methods (embryo transfer, in-vitro fecundation…) could help in improving camel milk production as fast as possible.

References

[1] **Abu-lehia I.H., 1989.** Physical and chemical characteristics of camel's milk and its fractions. *Food Chem.* **34** 261-271.

[2] **Bengoumi M., Faye B. and Tressol J.C., 1994.** Mineral composition of camel's milk in the southern Morocco. *In:* Dromedaries and camels, milking animals, October 24-26, Nouakchott, Mauritania. Ed. CIRAD-EMVT, Montpellier France.

[3] **Bengoumi M., Kouniba A., Vias G. & Faye B., 2002.** Camel milk and traditional cheese in the subsaharian Africa. Cheese Art 2002, 04-09 June 2002, Ragusa, Italy.

[4] **El Agamy E.I., Ruppanner R., Ismail A., Champagne C.P. and Assaf R., 1996.** Purification and characterisation of lactoferrin, lactoperoxidase, lysozyme and immunoglobulins from camel's milk. *Int. Dairy J.* **6** 129-145.

[5] **Farah Z. and Bachman M.R., 1987.** Rennet coagulation properties of camel milk. *Milssweissenschaft* **42** 686-692.
[6] **Farah Z., 1993.** Composition of camel's milk. Review article. *J. Dairy Res.* **60** 603-626.
[7] **Faye B., Bengoumi M. & Hidane K., 1998.** Elevage laitier périurbain. Cas de la région de Laâyoune au sud du Maroc. Actes de l'Atelier International sur l'Elevage périurbain. Ed. CIRAD-EMVT, Montpellier, France, pp 103-108.
[8] **Faye & Bengoumi, 1999.** Guide de l'élevage du dromadaire. Ed. Sanofi, Libourne, France.
[9] **Faye B., Bengoumi M. et Barkat A. 2003.** Le développement des systèmes camélins laitiers périurbains en Afrique. Atelier FAO Lait de chamelle, 08-10 october, Niamey, Niger.
[10] **Gnan S.O., Mohamed M.O., Shereha A.M. and Igwegbe A.O., 1994.** Antimicrobial activity of camel's milk. *In:* Dromedaries and camels, milking animals, October 24-26, Nouakchott, Mauritania. Ed. CIRAD-EMVT, Montpellier France.
[11] **Gnan S.O., Mohamed M.O., Shereha A.M. and Igwegbe A.O., 1994.** Fermentation ability of camel's milk. *In:* Dromedaries and camels, milking animals, October 24-26, Nouakchott, Mauritania. Ed. CIRAD-EMVT, Montpellier France.
[12] **Jardami-Maatouk Z., 1994.** Comparaison de la composition en caséines et de l'aptitude fromagère du lait de vache et du lait de dromadaire. Thèse Doct. I.N.P. Lorraine, Nancy, France.
[13] **Knoess K.H., Makhudum A.J. Rafiq M. and Hafeez M., 1986.** Potentiel laitier de la chamelle-plus particulièrement au Punjab Makistanais. *Rev. Mond. Zoot.* **57** 11-21.
[14] **Lambert J.C., 1994.** La transformation fromagère et le nomadisme : exemple du Niger. *In:* Dromedaries and camels, milking animals, October 24-26, Nouakchott, Mauritania. Ed. CIRAD-EMVT, Montpellier France.
[15] **Loiseau G., Faye B., Serikbaeva A., Montet D., 2001.** Enzymes ability to serve as markers of pasteurized camel milk. Int. Conf. on new horizons in biotechnology, April 18-21, Trivandrum, India.
[16] **Male M., Bengoumi M. & Vias G., 2003.** Contrôle enzymatique de la pasteurisation du lait de chamelle et mise au point d'un test de pratique de terrain. Atelier FAO Lait de chamelle, 5-8 Nov., Niamey, Niger, 88-94.
[17] **Mehaia M. A. and Al-Kanhal M.A., 1989.** Studies on camel and goat milk proteins: nitrogen distribution and amino-acids composition. *Nutr. Rep. Int.* **39** 351-357.
[18] **Mehaia M.A., Hablass M.A., Abdel-rahmane K.M. and El-Mougy A., 1995.** Milk composition of Majaheim, Wadash and Hamara camels in Saudi Arabia. *Food Chem.* **52** 115-122.
[19] **Pacholeck X., Vias G., Faye B. and Faugère O., 2000.** Elevage camelin au Niger. Référentiel zootechnique et sanitaire. Ed. ONG Karkara, Niamey, Niger.
[20] **Ramet J.P., 1990.** Processing of dairy products form camel's milk. Mission Report Saudi Arabia, FAO, Roma, Italy.
[21] **Ramet J.P., 1991.** La transformation en fromage du lait de dromadaire. *Rev. Mond. Zoot.* **67** 20.
[22] **Ramet J.P., 1993.** La technologie des fromages au lait du dromadaire *(Camelus dromedarius)* Etude FAO, Production et santé animales 113: 1-109, Roma, Italy.
[23] **Ramet J.P., 1994.** Les aspects scientifiques et technologiques particuliers de la fabrication de fromages au lait de dromadaire. *In:* Dromedaries and camels, milking animals, October 24-26, Nouakchott, Mauritania. Ed. CIRAD-EMVT, Montpellier France.
[24] **Shalash M.R., 1983.** The production and utilisation of camel milk. *Egypt J. Vet. Sci.* **20** 1-11.
[25] **Shalash M.R., 1984.** The production and utilisation of camel milk. *In:* The Camelid an all purpose animal. 196-208, W.R. Cockril Ed. Scandinavian Institute of african Studies Uppsala Sweden.
[26] **Simpkin S.P., Rowlinson P., Tullu D., Lesorogol P., 1997.** A comparison of two traditional camel calf management systems in Kenya and implications for milk production. J. Camel Pract. Res., 4(2), 229-234.
[27] **Yagil R. and Etzion Z., 1980.** Effect of drought conditions on the quality of camel milk. *J. Dairy Res.* **47** 159-166.
[28] **Yagil R., Zagorski O., Van Creveld C. & Saran A., 1994.** Science and camel's milk production (some keys for nutrition and marketing). *In:* Dromedaries and camels, milking animals, October 24-26, Nouakchott, Mauritania. Ed. CIRAD-EMVT, Montpellier France.

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Pasture Ration of Arvana Camels in Desert Pastures

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Abstract. The natural conditions of Turkmenistan caused the camel breeding as one of the inherent branches in desert stock raising. The camel breeding gives an opportunity to considerably improve the use of the desert pastures on droughty territories covered with the rarefied wormwood- halophytic plants. The pasture ration of the arvana camels during the maintenance on the sandy Karakum pastures mainly consists of the vegetating and dry twigs of the bushes *Haloxylon persicum,Calligonum sp.Salsola Richteri,Ephedra strobilacea* and partly spring and spring-summer grasses. On the pastures of gypsum and clay desert basic the fodder for the camels are different forms of the wormwood *Artemisia sp* and annual saltwort from the kinds of *Climacoptera, Salsola, Gamantus* etc. In the article there are described seasonal changes in the pasture ration of the camels at the maintenance on the desert pastures.

The natural conditions of Turkmenistan caused the camel breeding as one of the inherent branches in desert stock raising. The camel breeding gives an opportunity to considerably improve the use of the desert pastures on droughty territories covered with the rarefied wormwood- halophytic plants. Camels willingly eat up many plants unfit for other animals; therefore the camels breeding do not pinch the interests of the stock raising basic branches.

Camel is the pasture animal. Basic and best fodder for the camels is pasture vegetation represented predominantly by saltwork plants, wormwoods and in less degree by gramineous and bean grasses.

The specific camels fodder is perennial legumes plant prickle (yandak)-*Alhuagi pseudoalyuagi*. In Turkmenistan the camels are maintained on the desert pastures around the year. The carrying capacity of pastures for one camel per annum on the sandy pastures is 30 ha, on wormwood- halophytic pastures is 24-26 ha.(1) During the arid and barren years these standards can increase twice. Camels are grazed only during the day, at night they take rest. The one of the important special camel's features is its need in fresh green vegetation. The camel eats up and masters dry fodders considerably worse than pasture forage. On pasture the camel thoroughly selects necessary plants, tears away the most nourishing part: leaves, flowers, fruits. The edibility of the separate forms of vegetation by camels has seasonal nature. In order to provide camel with pasture fodders for the year round it is necessary to know the edibility of different plants at the different seasons. The daily need in grass for camels varies near 24-25 kg, in canopy about 6-12 kg. The camel consumes nutrients more economically than other types of herbivorous.

The pasture ration of the Arvana camel maintained on sandy Karakoum pastures consists of the spring vegetating twigs of *Haloxylon persicum, H.aphyllum, Astragalus unifoliolatus, Smirnovia turkestanica*, green branches of *Calligonum setosum, h. eriopodium, h.arborescens, Ephedra strobilacea, Salsola Richteri*, partly spring grasses - *Carex physodes, Malkolmia Turkestan, Isatis violascens, Eremopyrum orientale, Anisantha tectorum*

etc. In the summer time camels eat up basically green branches of *Salsola arbuscula, S.Richteri, Haloxylon persicum, H. Aphyllum, Halathamnus subapyuilla* and in insignificant quantity the grass at the spring-summer time. In the autumn on the sandy pastures the basic fodder for camels is the fructiferous and drying branches of *Haloxylon persicum H. Aphyllum, Salsola Richteri, Halathamnus subaphilla*, and in insignificant quantity the dead wood of large grasses. In winter period the camels willingly eat up the dry branches of *Haloxylon persicum, H. aphyllum, Ephedra strobilacea*, and in an insignificant quantity of *Salsola Richteri* and *Halathamnus subaphilla*.

In the western regions of Turkmenistan, on the pastures of gypsum and clay desert, basic fodders for the camels at the spring season are different types of wormwood: *Artemisia cemrudica, A. turanica, A. badhysi, A. santolina*, and also *Haloxylon aphyllum*, and partly spring grasses. In the summer time, camels graze the green vegetating sprouts of *Artemisia cemrudica, A. badhysi, A. santolina, Salsola orientalis* and in insignificant quantity annual saltwork plants *Climacoptera lanata, Gamantus gamocarpus* etc. In autumn the camels better eat up *Salsola gemmascens, S. orientalis, Anabasis salsa*, different forms of *artemisia* and annual saltwork plants. In the winter on the bush pastures of Western Turkmenistan the basic camel's fodder is the dry fruit-bearing branches of *Yualokhylon* sp., *Haloxylon aphyllum, Salsola orientalis, S. gemmascens,* varieties of *Artemisia*, and also annual saltwork plant *Climacoptera lanata, Gamantus gamocarpus, Salsola sclerantha* which are widespread on these pastures, especially in the humid years.

References

[1] The system of the agriculture management in Turkmen SSR, Ashgabat, Ylym, 1978, p.269-273.

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Meat Productivity of the Camel Arvana Breed and Ways to Increase It

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Abstract. The weaning is traditionally late in Turkmenistan camel breeding. Early weaning at 6 or 9 months old is possible with improved feeding. Significant increase of growth rate and favorable change in carcass composition could be get. Recommendations are done for meat productivity improvement in Turkmen farms.

Introduction

Under the natural climatic and pasture conditions of Turkmenistan the camels of the Arvana breed play important role in the solution of the food supply for human population. Their number at the beginning of 2004 year is 123.7 thousand heads, among them 28.1 % are in the state farms and 71.9 % in private sector. Thanks to this sector, there are yearly produced by 8-10% of gross volume of meat. The camel meat, especially from young animals is characterized by high tasty and dietetic properties. At the same time, this sector is conducted extensively. New feeding technologies and contents are not introduced, contrary to practices in other sectors of stock breeding.

Material and Methods

The experiment was performed on Arvana breed at Sakarchaga farm (Mary district). An experiment was carried out on the early weaning of young camel in three versions. In the first version the weaning of young camel was carried out in the age of 16 - 17 monthly. Basic task with this version consisted in the study of the possibility to conduct early weaning of young camel. In the second version, after the finding of this possibility and refining of its parts, an experiment was carried out of the weaning of young camel at the age of 9 months. In this case there was studied their height and development, the results of fattening, determined slaughter output and quality of meat. In the third version the weaning of young camel at the age of 6 month with their subsequent feeding to 24 months was studied. The experiment included 20 heads of young camel – from which 10 heads males were control group and 10 were experimental. Animals of control group were located on the pasture maintenance and used maternal milk till the age18 of months.

Experimental young camel during 6 – 9 months got daily 0.25 kg of concentrates, 2 kg of rough fodders (camel prickle, cotton husk), at 9 – 12 months respectively 0.5 and 3.0 kg; 12 – 15months 0.75 and 3.0 kg; 15 – 18 months 1.0 and 4.0 kg; 18 – 21 months 1.0 – 4.5

Table 1. The slaughter qualities of young camel.

Indexes	12 months			18 months			24 months		
	Groups			Groups			Groups		
	Experiment.	control	Diff.	Experiment.	control	Diff.	Experiment.	control	Diff.
Quantity, heads	3	3		3	3		3	3	
Living mass, кg	273.2	232.0	17.8	332.3	297.2	11.8	491.3	418.0	17.5
Bulk mass, kg	142.5	121.1	17.7	183.4	161.1	13.7	226.5	189.0	19.8
Fat mass, kg	16.2	14.1	14.9	19.5	18.3	6.6	28.6	22.4	27.7
Including internal fat	2.8	2.7	3.7	1.3	1.0	30.0	2.6	1.5	73.3
Perinephric fat	0.9	0.7	28.6	1.5	1.0	50.0	3.4	2.3	47.8
Humped fat	6.8	5.9	15.3	8.5	8.4	1.2	11.1	9.1	22.0
Inguinal fat	5.7	4.8	18.7	8.2	7.9	3.8	11.5	9.6	19.8
Slaughter mass, kg	158.7	135.2	17.4	202.9	179.6	12.9	255.1	211.4	20.7
Slaughter output, %	69.1	69.7	-0.8	61.0	60.4	0.6	51.9	50.5	1.4

kg; 21 – 24 months 1.5 and 6.0 kg. At the end of the experiment, young animals, were slaughtered at the age of 12, 18 and 24 months under the conditions of camels farm.

Results

Our studies showed that the early weaning of young camel at the age of 9 and 6 months considerably increases the intensity of the growth of young animals. So, their males already in 12, 18 and 24 months age can be driven into the meat production.

1. Slaughter Quality (Table 1)

All indices of slaughter quality in early weaning animals (experimental group) exceeded control animals. This superiority at the age of 12 months comprises: throughout pre-slaughter mass 17.8%, mass flourishes to 17.7% mass of fat to 14.9%, slaughter mass to 17.4% and slaughter output to 0.8%. At the age of 18 months, it was respectively: 11.8%, 13.7%, 6.6%, 1.9% and 0.6%. At the age of 24 months early weaned young camel exceeded control group according to the above indices respectively: 17.5%, 19.8%, 27.7%, 20.7% and 1.4%. It should be noted that at the age of 18 months, the quantity of hump fat reached 8.4 – 8.5 kg, and into 24 months, 9,1 – 11,1 kg.

It could be emphasized that the experimental group of young camels obtaining additional feeding was considerably better provided with exchange energy and reached the higher indices of living and slaughter mass. At the age of 24 their living mass was 491.3 kg that on 17.5% higher than the control group. The same results were obtained with the other indices.

2. Morphological Composition of Carcass (Table 2)

The flesh part in the carcass from 12 months camel from experimental group was 69.7%, that on 1.0% more than in control animals; in 18 months young camel, it was 60.9 and 6.5%; 24 months: 56.6 and 5.1%.

Per 1 kg of the bone, flesh quantity in animals from experimental and control groups at 12 months was respectively. 2.7 and 2.6 kg, at 18 months respectively 1.6 and 1.2 kg, while at 24 months it was 1.3 – 1.0 kg.

Table 2. The carcass morphological composition.

	Unit.	12 months			18 months			24 months		
		Groups			Groups			Groups		
		Experiment.	control	Diff. (%)	Experiment.	control	Diff. (%)	Experiment.	control	Diff. (%)
Quantity	Un.	3	3		3	3		3	3	
Fresh-killed mass	Kg	142.5	121.1	17.7	183.4	161.3	13.7	226.5	189.0	19.8
Flesh	Kg	99.4	83.6	18.9	110.2	86.4	27.5	128.3	97.2	32.0
	%	69.7	69.0	1.0	60.1	53.6	12.1	56.6	51.5	9.9
Bones	Kg	37.2	32.4	14.8	70.8	72.2	-1.9	98.3	91.8	7.1
	%	26.1	26.7	-0.9	38.6	44.8	-13.8	43.4	48.5	-10.5
Flesh on 1 kg of bone	Kg	2.7	2.6	3.8	1.6	1.2	33.3	1.3	1.0	30.0

Table 3. Chemical content and caloricity of camel's meat according to the age of slaughtering (in months).

Age	n	Water %		Protein %		Fat %		Ashes %		Meat Calory 1 kg, kcal		
		Groups		Groups		Groups		Groups		Groups		
		Exp.	Control	Exp.	Control	Exp.	Control	Exp.	Control	Exp.	Control	Diff.(%)
12	3	76.4	76.6	20.1	20.1	2.7	2.4	0.8	0.9	5858	5754	1.8
18	3	66.6	70.6	14.7	16.7	17.9	11.8	0.9	0.9	2244	1765	27.1
24	3	70.9	71.6	14.2	14.5	14.5	13.4	0.5	0.5	1926	1817	6.0

3. Meat Composition

The quality of meat was studied by its chemical composition (table 3). Obtained data show that the meat of experimental group of young camel at 12 months age exceeded control animals for the fat content, and was inferior on the moisture rate. Similar pattern was observed at 18 and 24 months.

On the basis of chemical composition for meat, caloricity was determined for 1 kg meat. According to this index experimental group of young camel exceeded at 12 months in comparison to control group on 1.8%, at 18 months on 27.1% and at 24 month on 6.0%. Thus, the meat of the experimental group of young camel of males proved to be most caloric and most nourishing.

Study carried out made it possible to develop recommendations regarding the early weaning of the young camel of Arvana breed and the increasing of their meat productivity.

Practical recommendations [1–3]

1. On the camels farms as well state as private, it is possible to organize early weaning of young camel at age of 6 and 9 months with their subsequent additional feeding of fattening up to 24 months.
2. For conducting early weaning, it is necessary to organize valuable feeding and maintenance of groups of young camel. After weaning the groups of young camel during the day time are to be on the pasture, and in the evening they must get additional feeding.
3. Early weaning of young animals have to receive additional feeding according to the recommended standards to reach 273 kg at 12 months, 333 kg at 18 months and 492 kg at 24 months, and can be used for slaughtering at defined age-qualification periods. This is on 1.0-1.5 years earlier than it is accepted at present.

References

[1] Mallaryň we guşlaryň sany baradaky maglumat. 2004-nji ýylyň Türkmenbaşy aýynyň 1-ne çenli. Türkmenistanyň milli döwlet hasabaty we maglumatlar instituty "Türkmenmillihasabat", Aşgabat, 2004.
[2] **Saparov K.** - Development and the meat qualities of young animals of the milk female camels of the Arvana breed Thesis k. of s/kh.n. Ashgabat, 1994.
[3] **Saparov K.** - "To develop effective the methods of increasing the productivity of the camels of the Arvana breed ", final report, the drain of fulfillment 1996-1998, Ashgabat, 1999.

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The Milk Productivity of the Camel Arvana Breed and Its Use

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Abstract. In Turkmenistan, camel of Arvana breed has been selected for different purposes and especially for milk production. Some lines of camels were selected in state farm. Its milk productivity could be high and reach more than 2500 kg of milk in one lactation. The milk production is higher in spring. Camel milk has medical and nutritional properties. Its processing into local traditional products is widely used in the country.

Introduction

Camel breeding is a traditional branch of livestock farming in Turkmenistan [1–3]. Camels are found on the desert pastures all the year and it is combined with sheep farming. During pasture, camel eats up the upper parts of bushes and trees which usually are not accessible for small livestock. Because of their biological features, the camels do not trample down pasture and do not disrupt the natural ecological balance.

On its significance in the life of man no other animal can be compared with the camel and as Turkmens they tell "Düýe maly dünýe maly", that means "Camel is life" since camel in contrast to other types of animals provides people not only with food products but also serves as transportation mean.

Turkmenistan is considered the native land of the dromedary of the Arvana breed. From the old times our ancestors, desert inhabitants used it as milk animal. The special biological feature of female camels in contrast to other animals is their ability to give milk with the annual pasture maintenance, and the lactation period duration (350-450 days). With good pasture fodder, they can go without water about three weeks [15].

The Milk Potential of Turkmen Camel Breeds

In the past the Turkmens – (Charvadars tribe - livestock breeders) among all camel's qualities of mostly valued its milk because it formed the basis of the human food ration under the desert conditions. And therefore Turkmens permanently conducted the camel's selection in this direction. Thanks to that, Turkmen female camels became high milk-producing.

Baymukanov [4] notes that among all camels' breeds, the Arvana is characterized by the highest milk productivity and they are successfully used for the improvement of the Bactrian's productivity. Tastanov [18] asserts that Turkmen dromedary have a smaller anoestrus period on 45-60 days than such of Bactrian's. Milk productivity in dromedaries exceeds

Table 1. Change the milk yields of female camels on the lactations in the conditions of Camels farm "Sakarchaga" in Mary district [14,15,20].

Lactation	Milk yield for 365 days, kg
First	1188
Second	1628
Third	1606
Forth	1676
Fifth	1822

the Bactrian's figure more than twice. According to Kugenov [10], dromedary's milk productivity is similar to cows. Their average milk yield for 18 months lactation reaches 4400 kg for the adult and 3400 kg at the first lactation. The average fat content of dromedary's milk is 4.5%, Bactrian's – 5.4%.

The lactation duration of the different camel breeds are different. In dromedaries, it is equal to 500-560 days, in Bactrians -520-540 days. Milk yield for the first lactation is comprised in dromedaries between 2800 and 3500 kg, for the second lactation it raises to 3400-5300 kg. The milk-producing capacity of Bactrian is below and is in average 770-1700 kg. Maximum daily milk yield in dromedary reaches 18-20 kg, in Bactrian - 3-7 kg with 5-6% fat content of milk. The milk yield of the female camels of Bactrian usually rises up to 4-5 lactations. The milk productivity of the dromedary female camels of the Arvana breed has been stabilized after the third lactation (table 1).

The comparative study of the dromedary, Bactrian and their hybrids on milk productivity in Turkmenistan showed that dromedaries have maximum milk-producing capacity but they have e lower percentage of fat in the milk than Bactrian and hybrids. The daily milk yield from 86 heads of female camels –dromedaries of Camels farm # 82 (Today's farm "Turkmenistan", Balkan district) on the second month of lactation is equal to 10.25 liters with the variability from 4,8 to 15.8 liters, the average milk yield of 11 hybrid was 9.43 liters [19].

In camel's farm "Sakarchaga" from Sakarchaga county, the effectiveness of breeding camels was studied for different selected families. In these conditions, 5 genealogical lines were used, three production types (milk-meat, wool-meat and meat-wool) were chosen and the thoroughbred dairy herd camels was created with the milk yield of 2482 kg with fatness 3.7% without taking into account suckling by young camel and with the living mass of more than 500 kg (table 2).

The average/mean milk productivity of selected adult female camels was 2665 kg of milk that on 183 kg is more than on the herd. Exceeding of the milk-producing capacity of female camels from the lines Batli, Selen and Gavers compared to average of herd index was respectively 365, 255 and 292 kg. More objective data on the level of the milk-producing capacity of animals shows the distribution of livestock of milk female camels on the value of average-daily milk yield (table 3).

The large part of livestock (87.4%) of the female camels of the line Batli has daily milk yield in limits of 7-10 kg of milk. Output of animals with this milk yield in Selen was – 57.3%, Gavers – 66.7%, Garagulak – 47.7% and in Goekgaplan – 41.5 %. In animals of the line Batli high milk-producing capacity was harmonized with their massiveness. The average-daily milk yield of female camels without taking into account the suckling of young is 7.8 kg. At present in the line Batli there are 294 heads of animals from which 118 heads of dams and 7 head of stock-breeding producers. They are used successfully in the improvement of the camel productivity in the camel farm "Dzheykhun" from Sakar region in Lebap district.

Table 2. Milk productivity of linear female camels without taking into account sucking by young camel.

lines	Number of heads	Lactation	Yield for 12 months
Batly	4	First	1971
	32	Third and older	2847
Selen	3	First	1898
	26	Third and older	2737
Gavers	6	First	1934
	27	Third and older	2774
Garagulak	3	First	1861
	23	Third and older	2518
Geokgaplan	4	First	1825
	12	Third and older	2445
Average	20	First	1898
	120	Third and older	2665

Table 3. Distribution of female camels in the value of daily milk yield.

Daily milk yield, kg	lines									
	Batly		Selen		Gavers		Garagulak		Geokgaplan	
	Heads number	%	Heads number	%	Heads number	%	Heads number	%	Heads number	%
1	2	3	4	5	6	7	8	9	10	11
5.0-5.5	0	-	1	3.8	1	3.7	3	13.0	3	25.0
5.6-6.0	0	-	1	3.8	1	3.7	3	13.0	2	16.9
6.1-6.5	2	6.3	5	19.3	4	14.8	2	8.7	1	8.3
6.6-7.0	2	6.3	4	15.4	3	11.1	4	17.6	1	8.3
7.1-7.5	4	12.5	2	7.7	3	11.1	2	8.7	1	8.3
7.6-8.0	9	28.0	4	15.4	3	11.1	2	8.7	1	8.3
8.1-8.5	5	15.6	3	11.5	6	22.3	3	13.0	1	8.3
8.6-9.0	4	12.5	2	7.7	3	11.1	2	8.7	1	8.3
1	2	3	4	5	6	7	8	9	10	11
9.1-9.5	2	6.3	2	7.7	2	7.4	1	4.3	-	-
9.6-10	4	12.5	2	7.7	1	3.7	1	4.3	1	8.3
Total	32	100	2	100	27	100	23	100	12	100

The Milk Quality and Properties

The study results on milk productivity and quality on camel farm “Sakarchaga” are given in table 4.

The greatest milk-producing capacity of female camels falls for the spring-summer period. Opposite results were obtained on the fat content of milk. It is high in autumn and low in summer. The high acidity of milk was observed in summer and low in autumn. Special attention attracted the questions connected with the quality of milk processing and use. On its gustatory qualities, nutritiousness and consistency the camel milk differs from the cow's and the horse’s milk. Its taste is pleasant, but depending on the eaten up vegetation: it can be somewhat salty. At the same time it is richer in minerals, contains more protein, and has the large fat content [9,15,20]. Thanks to the increased content of phosphorus and calcium, camel milk is valuable product for the nourishment of children and feeding new born farm animals [6].

Table 4. Change in milk-producing capacity and quality of milk of camel upon the seasons [5,16,17].

Figure	Unit	Seasons		
		spring	summer	Autumn
Daily yield	kg	5.8	5.3	4.7
Milk fat	%	3.63	3.98	4.13
Acidity	T^0	19.7	20.4	19.6

In the cow's milk predominates the casein fraction which is about 80%, and in the camel's milk it is about 70% of the total quantity of protein. In connection with this the camel milk is assimilated better than cow's. Camel milk is albumin milk [11]. Contrary to other milk from agricultural animals, camel milk can be stored in the fresh form for long time. Its bactericidal properties slow down the growth of acidity. At 10°C in the camel milk initial acidity remains three days, while in the cow's it grows continuously. At 30°C camel milk remained fresh for 24 hours, and cow's after 6 hours is curdled.

Camel is the pasture animal. Many camel farms are located some far from the large populated areas. That's why storage and the transport of camel milk becomes one of the most important problems for the milk use. To study this question on Camel farm "Sakarchaga", a series of observation of the camel milk acidity growth under different temperature conditions were carried out (in the refrigerator at a temperature 8-10°C, in the shadow under the shed at a temperature 28-40°C and under open air at a temperature 28-50°C). The acid test of milk finished upon the achievement of acidity level to 25-26^0 T. The study results show that the milk acidity growth in many respects depends on temperature. In this case, under the shed at a temperature of air 28-40°C milks can keep normal freshness to 8-10 hours, with 28-50°C to 5-6 hours and at a temperature 8-10°C (in the refrigerator) to 13-14 hours. The above shows that camel milk can be stored sufficiently for prolonged time that confirms its high bactericidal property.

The transport of camel milk was carried out on the open vehicle at the air temperature of 21-30°C and above. In this case the milk remained fresh to 4-5 hours, i.e. for 0.5-1 hours less than in calm state what was connected with the intensive development of microbiological processes in the milk after shaking. The fat of camel and mare milk is considerably richer with polyunsaturated fatty acids [7]. This specifies the bactericidal action of the fat of these types of milk, the low melting point and thickening, and also high iodine index.

The fatty balls of camel milk in comparison to cow's have smaller size, and more easily will be hydrolyzed and better assimilated by organism. Increasing bactericidal action of camel milk is valuable quality for practical use. It makes possible to prolong the periods of its transport, storage and processing.

Camel Milk Processing

Camel milk serves as a good basis for the preparation of the new forms of production. Turkmens traditionally make such drinks as *chal*, *agaran*- cream, *suzma*, and they are also used in fresh form. These products are traditionally used by people for treating different diseases [8,9]. The *chal* possessing larger nutritiousness has dietetic, therapeutic value against the dangerous in desert (because of the absence of fresh vegetables) disease as scurvy [19]. Production for people prescription is simple, the water is added to the previously turned sour camel milk and it is ready in the specific time.

A new beverage from the camel milk called *doyran* was proposed in 1985 [12–14]. Method of its preparation: the entire camel milk is spill into bottles where fermentation

starts. This beverage contains a large quantity of group D vitamins; its fat content is higher. Standards and technical specifications for the sour-milk products such as *chal*, *agaran*-cream, *doyran* are developed. The production is processed in GPZ "Sakar-Chaga" with the delivery to the therapeutic and children's centers of Mary district.

Conclusion

From the above it is possible to conclude that the camels of the Arvana breeds can have great value in the providing of population of Turkmenistan with high-calorie dairy products with unique therapeutic properties and without high expenditures for their production. Great possibilities for the development of camel breeding in our country were opened after finding by Turkmenistan independence. In 1996, by the decision of the President of Turkmenistan, the association of the cattle-breeding joint-stock companies "Turkmenmallary" was organized and stock raising was put into a new lease conditions of conducting and all taxes to the carrying out of cattle-breeding production were removed.

Complete gasification of the entire country removed the need for the cutting down of pasture bushes to the firewood. All this created conditions for increasing the productivity of pastures and was the push of the development of stock breeding. In the years of independence, sharply increased of the camel livestock occurred (by 37%) and increased the number of farmer- owners, who carry out camel breeding. In 2002 years in the country there were produced 2402 tons of camel milk, and 98.7% were produced in private sector. At present the markets for the country each day are enriched with excellent sour-milk food products from the camel milk in the broad spectrum and are sold on the price accessible for the purchase. In Karakum, the construction of Turkmen lake was started. It will accumulate drainage waters from all districts. This will considerably improve the pastures watering and will create new possibilities for further increase in livestock and growth of the production of camel breeding.

References

[1] The Livestock of cattle and bird of Turkmenistan. The Control Statistical Administration of Turkmenistan, 1991.
[2] 2002-nji ýylda öndürilen maldarçylyk önümler – Türkmenistanyň milli döwlet hasabaty we maglumatlar instituty. "Türkmenmillihasabat", Aşgabat, 2003.
[3] Mallaryň we guşlaryň sany baradaky maglumat. 2004-nji ýylyň Türkmenbaşy aýynyň 1-ine çenli – Türkmenistanyň milli döwlet hasabat we maglumatlar instituty "Türkmenmillihasabat", Aşgabat, 2004.
[4] **Baymukanov A, 1991.** Zootechnical bases for productivity increase and perfection of the technology of milk camel breeding - thesis by the competition of the scientific degree of the doctor of agricultural sciences in the form of scientific report, Alma-Ata.
[5] **Cholukov Ch., Berkeliyev T., Saparov K., Seyitniyazov A., 1981.** Creating the way of increasing the productivity of the camels of the species/rock of arvana. - Final report for the years 1976-1980, Ashgabat, p. 62.
[6] **Izmailov T.U., 1981** The interconnection of the function of rumina/proventriculi/gizzards with the milk productivity of ruminant animals - in the book: "The problems of the development of camel breeding in Kazakhstan", "Kaynar", p.103-107.
[7] **Kadyrova R. KH., 1985.** Camel and mare milk in the therapeutic nourishment, Alma Ata, Kazakhstan, s. 160.
[8] **Khodzhakuliyev G.K, 1964.** The content of vitamins A_1, B_1, B_2 and C in the camel milk. Zh. "Collective farm- state farm production TSSR".
[9] **Khodzhakuliyev G., 1965.** Chal and itstherapeutic properties - author's abstract of thesis to the competition of the scientific degree of the doctor of medical sciences, Ashgabat.
[10] **Kugenov P.V., 1974.** The dairy matter. Publ. electronic unit, Pererab. to dopa. M., "ear".

[11] **Kugenov P.V., 1981.** Camel milk - highly nutritious product - in the book: the "problems of the development of camel breeding in Kazakhstan", "Kaynar", s.9ya-98.
[12] **Musakarayev T., Saparov K., 1985.** How correctly to prepare the *chal*. Magazine "The agriculture of Turkmenistan", p. 16-17.
[13] **Musakarayev T., Saparov k., Nazarov k., Orazmamedov Kh., 1991.** "To create the dairy thoroughbred herd of camels with the milk yield 2500 kg, the fat content of milk 3.5% and a living mass of 500 kg. - Final report for the years 1986-1990, Ashgabat, 19.
[14] **Musakarayev T., Saparov k., Cholukov Ch., 1986.** Creating the ways of the intensification of camel breeding in TSSR. - Final report for the years 1981-1985, State of registration 01830077457, Ashgabat.
[15] **Rakhmanberdiyev S.A., 1981.** Milk yield and the chemical composition of milk in female camels - in the book: the "problems of the development of camel breeding in Kazakhstan", "Kaynar", p. 99-102.
[16] **Saparow G., Çolukow Ç., Alymow G., 2003.** Sakar etrabynyň "Jeýhun" daýhan birleşiginiň şertlerinde arwana tohumly düýeleriň ýokary önümli sürüsini döretmek. – Jemleýji hasabat (1999-2002 ýyllar), Aşgabat.
[17] **Saparow G., Çolukow Ç., Alymow G., 2003.** Sakarçäge düýedarçylyk hojalygynda arwana düýeleriň nesil ugurlaryny dikeltmek we seleksion – tohumçylyk işini ýokarlandyrmak. – Jemleýji hasabat (2000-2002 ýyllar), Aşgabat.
[18] **Tastanov A., 1981.** Some results of the methods of obtaining the highly productive hybrid animals of milk trend - in the book: the "problems of the development of camel breeding in Kazakhstan", "Kaynar", p. 53-63.
[19] **Usmanov F.A., 1941.** The camel breeding in Krasnovodsk and Ashkhabad districts "transactions of Turkmen experimental station on the stock raising", volume 2, Turkmengosizdat, Ashgabat, p. 133-164.
[20] **Zhangabylov A.K., Servetnik-Chalan G.K., Cherepanov V.P., Belokobylenko V.T., Knysh V.S., Lukovina R.I., Zhaksylykova R.D., 1981.** About therapeutic and dietetic properties of camel milk - in the book: Problems of the development of camel breeding in Kazakhstan, Kaynar, p. 117-120.

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Wool Productivity and Quality of Fleece in the Camel Arvana Breed

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Abstract. In Turkmenistan, the wool production is one of the camels farming interest. The wool production varied from 1.8 to 3.4 kg of fleece. The color is in majority brown or reddish-brown. The length of the fiber is more important in the hump. The camel wool can be used for many kind of clothes.

Introduction

In Turkmenistan, 33 thousand ton of fleece is yearly produced, including 1.5 thousand tons of camel's one [2]. Camel fleece is valuable raw material for the light industry. The camel wool productivity has been deeply studied in the country.

Wool Productivity

It is established that the average woolen productivity of the adult camels of the Arvana breed of equal to 2.1 kg with the oscillation 1.8-2.5 kg [5]. Fleeces clip in young animals rises in the period from the 1 to 3 years age. With start of calving and lactation the productivity is reduced [4]. The conducted researches [1] in the specialized camels farm "Sakarchaga" in Sakarchaga region (Mary district) showed that the woolen productivity of the camels of Arvana breed proved to be between 3.4 ± 0.20 kg in adult male and 1.8 ± 0.06 kg in 2-years females (table 1).

It is established that with conducting the early weaning of young camels at 6 months age (under the traditional conditions the weaning is carried out at the age of 18 months) and the organization of additional feeding it is possible to increase their wool productivity. These indices rise in 1 year old females by 4.3%, males – 4.0% and in 2- years old animals respectively 11.1 and 10.0%, compared to the groups of animals which maintained under the normal conditions.

Wool Quality

The overall length of fleece in the age-qualification aspect is depending on their arrangement around the body. For this purpose, the measurement of the overall length of fleece

Table 1. Wool productivity in the camels of the Arvana breeds.

Sex-aged groups	n	Wool clip, kg
Camels-bulls	10	3.4±0.20
Camels dams	20	2.7±0.09
2 years old males	10	2.0±0.15
2years old females	20	1.8±0.05
1 year old males	10	2.5±0.07
1 year old females	20	2.3±0.06

Table 2. Age-specified dynamics of wool length in young camels depending to it location on the body.

Age of young camels-females	Body part and length of wool, cm				
	hump	neck	sides	thigh	back
At birth	14.8±0.16	4.5±0.11	7.8±0.19	7.6±0.26	8.2±0.19
6 months old	15.5±0.15	5.2±0.10	8.5±0.18	7.9±0.41	8.8±0.18
12 months old	17.0±0.15	6.2±0.09	9.6±0.17	9.4±0.23	10.4±0.18

group of young camel - females (n=20) was achieved in the hump, the neck, the sides, thigh and the back (table 2).

The length of fleece increased significantly with the age of animals. Moreover this increasing is identically independent of its location. From the birth to 6 months age the increasing of the length of fleece varied from 4% on the side to 15.5% on the neck. More intensively it grew from 6 to 12 months ages - from 9.7% on the hump to 19.2% on the neck. Thus, the greatest length was the fleece of hump; smallest (short) was on the neck. On the back, the side and the thigh it was practically identical, the difference being insignificant. Similar results were obtained in young camel- males (n=10). The color of fleece in Arvana breed are light brown, reddish brown and dark-brown.

The proportion of the color of fleece in females was studied among 60 camel heads [1]. In this study, 20% (12 heads) of females had light brown color, 50% (30 heads) - reddish brown color and 30% (18 heads) had dark-brown color. In group of young camel- females (n=40) from the birth to 12 months ages the color of fleece was extended in the following way: 17.5% (7 heads) had light brown; 72.5% (29 heads) reddish brown and 10 % (4 heads) dark-brown color. Thus in the Arvana camels, light brown and reddish brown colors are encountered in the majority of cases: about 70% of females and about 90% of young camel had the same color. It is known that interconnection occurred between the color of the woolen cover of the Arvana camels and the environment. Propagation mainly of the bright color is connected with the adaptation of the camels of the Arvana breed to the hot Karakum desert climate conditions. It should be noted that the color of wool in the Arvana camels at the birth does not change in their subsequent life.

For the purpose to obtain the valuable information about the quality of the camels fleece of the Arvana species we studied the samples of fleece, undertaken from the camel- bulls (n=9 of heads) and camel-dams (n=9 of heads). Works had been executed in the institute laboratory (table 3).

The fleece of camel- bulls contained downy fibers -71.3%, transitional -19.8% and barb -8.9%; these indices in camel- dams are equal to respectively 86.1%; 9.2% and 4.7%. In camel-bulls the thickness of downy fibers proved to be 21.9 μm, transitional fibers 41.4μm and barb fibers 58.7 μm. These values in camel-dams proved to be respectively 18.8 μm, 40.0 μm and 58.0 μm. The output of the washed fleece reaches in camel- bulls 84.1%, in females -79.3% [3].

Table 3. Wool qualities in Arvana camels.

Group	n	Pure wool outcome %	Wool Morphological content, %			Thickness of wool fibers, μm		
			Downy fibers	Transitive fibers	Barb fibers	Downy fibers	Transitive fibers	Barb fibers
Camel-bulls	9	84.1	71.3	19.8	8.9	21.9	41.4	58.7
Camel-dams	9	79.3	86.1	9.2	4.7	18.8	40.0	58.0

The conducted investigations testify the value of camel fleece for the light industry. Furthermore this raw material is produced without large expenses under the conditions of pasture maintenance.

Conclusion: The Use of Camel Wool

In Turkmenistan the camel wool is processed in the private sector. In household conditions as a result of the hackling and spinning, yarn is obtained. It is used in its natural color (without any dyeing) for the production of national clothing – cakmens (light coat for the elderly men) and national tablecloths. These articles are produced via weaving. Camel fleece in small volume is used for preparing of various sweaters. Furthermore it is used for preparing the therapeutic belts against arthrosis. With the establishing of new technology to process camel fleece on the industrial basis it would be possible to prepare outcome of different assortment, especially warm clothing because camel fleece is characterized by unique heatproof property, morphological composition, thickness of fibers and strength.

References

[1] **Analgadiyev O., Saparov G., 1999.** Final report on the theme: “to develop the effective methods of increasing the productivity of the camels of the species/rock of arvana”, NIIZhiV, Ashgabat.
[2] Information “Turkmenmillikhasabat”, Ashgabat, 2003.
[3] Jemleýji hasabat: “Sakarçäge” düýedarçylyk hojalygynda arwana düýeleriniň nesil ugurlaryny dikeltmek we seleksion tohumçylyk işini ýokarlandykmak”, YBMWI, Aşgabat, 2003.
[4] **Donchenko V.V., 1949.** The “ways of the selection of dromedary”, Izv. of Turkmen fil. AS USSR.
[5] **Okorokov A.Y., 1968.** The “Turkmen dromedaries of the Arvana species”, Ashgabat.

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Final Recommendations

The international workshop on Desertification Combat and Food Safety – The Added Value of Camel Producers was held at Ashkabad from 19 to 21 April 2004. Forty scientists from sixteen different countries including Turkmenistan attended the workshop which was funded by the NATO Public Diplomacy Division and supported by the French Embassy. It was organised in Turkmenistan by National Institute of Desert, Fauna and Flora (NIDFF) and the National Institute of Livestock and Veterinary Medicine (NILVM) and in France by CIRAD-EMVT. The workshop has highlightened the importance of regional and international cooperation on desertification combat and camel sciences, the importance of the preservation of biodiversity in desert areas and of the pastoralist way of life, the necessity to strengthen the capacity building of the actors of camel sub sector (scientists, technicians and farmers), the importance of the promotion of camel research, especially to improve camel products and marketing, and finally, the interest to structure the international scientific community devoted to camel farming and biology of camel. At the end of this workshop, the following final recommendations were made:

1. To encourage regional cooperation to combat desertification. The camelids will contribute to the long term sustainable use of deserts and dry grassland,
2. To investigate the cause and to assert the severe decline of camel numbers especially in Asia, and bring it to the attention of governments and governmental bodies,
3. To ensure that the current efforts for the survival of the wild Bactrian camel are made sustainable,
4. To develop a continuing technical education programme for scientists and practitioner in the Central Asian region, to acquire expertise in recent developments in camel health and management,
5. To collect more information on camel milk and meat production in pastoral conditions especially in Central Asia where data are scarce,
6. To perform breed selection studies for camel specific production: milk, meat and wool,
7. To perform fundamental studies on medical properties of camel milk,
8. To spread practical information to farmers and dairies relative to processing of milk pasteurization and conservation (notably cheese making),
9. To perform more studies on the economy of camel milk and camel meat market,
10. To establish an international body to look after the interests of camelids worldwide and hold workshops at regular intervals.

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