

# CAMEL RESEARCH ARTICLES

# ABSTRACTS

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Somali Pastoral and Agro Pastoral Research Institute (SoRPARI)

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Somali Pastoral and Agro Pastoral Research Institute (SoRPARI)



# Camel Research

## **Vision**

To see improved livelihood of the pastoral and agro-pastoral communities through generating and applying sustainable camel production technologies

## **Mission**

Generate technologies that improve camel productivity and nutrition quality for sustainable food security and economic development of the pastoral and agro-pastoral communities.

## **Goal**

Generate and adapt improved camel production technologies



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# Forward

In-depth knowledge about the economic potentiality of the camel is lacking. Camel development should understand in line with the government's efforts in changing the livelihood of pastoralists and economic growth at the national level. Focusing camel development means the entering points or the easiest way to promote the broader pastoral system development.

Based on the information Livestock Master Plan 2014 the camel population in Ethiopia is estimated to be 4.5 million and the one-humped camel dromedary (*Camelus dromedarius*) found in the pastoral and agro-pastoral areas of Ethiopia. The majority of pastoralists and agro-pastoralists' income generation depend on the camel. Camels are in high demand since they can reproduce with minimal difficulties and produce an adequate amount of milk even during adverse weather conditions as compared to other domestic animals. Due to its unique anatomical, physiological, and behavioral adaptive features, the camels are well adapted to hot arid and semiarid areas irrespective of the excessive heat load from the environment, shortage of feed, and drinking water. The camel research initiatives directed toward improving the production and productivity of camels is believed to improve the livelihoods of pastoral communities. Research results based on pastoralists' needs and natural resources will play a significant role in food self-sufficiency and security, which is a big challenge in the dry-land areas of the country.

Camel often referred to as the “*ship of the desert*”, is highly valued by the herders for both economic and social reasons. It is the most drought-resistant livestock species, which saves the lives of the herders and their families during stress periods. Camel is not only a source of food and other products (e.g. milk, meat, hides, and skins) but also a major means of transport, ensuring pastoralists and their goods' movement from one place to another.

Nevertheless, the current productivity and production levels of camel show that their potentials are yet to be fully exploited. The entire camel population of the country is owned and managed by pastoralists who practice extensive herding. Their environments are characterized by frequent droughts, feed shortages, and water scarcity. Subsequently, not only camel productivity and production remain low and unreliable, but also their population dynamics exhibit a "boom and bust" pattern of rapid growth followed by precipitous crashes. These constitute a large economic loss for society, making them dependent on foreign food aid.

In response to these problems, national camel coordination policy change with regard to camel research and development has been initiated and proposed by the Somali Region Pastoral and Agro-pastoral Research Institute (SoRPARI). The purpose of the proposed new camel intervention is to improve camel husbandry, health, productivity, marketing, nutrition, and management using an innovative and integrated approach. Major components of the integrated project include the development of high-value

camel feed, adequate water supply sources, improved camel husbandry, and marketing. This will, eventually, alleviate fodder and water scarcity, restoring degraded rangeland, helping avoid the decline of their health status and distress disposal of stock. To add value and exploit their potential, the integrated project will promote commercialization and industrialization of camel and camel products. The project is expected to boost the local and national economy and reduce the vulnerability of the herders to recurrent drought. Therefore, it is in our greatest interest to have the government and other stakeholders focus toward camel development and provide required financial assistance, and capacity building to help the proposed new camel project and work in partnership with us to change the livelihood of camel pastoralists and to be able to exploit the untouched resources for contributing economic development at the national level.

The research endeavors that attempt to address the problem of camel pastoralists are few and concentrated on generating baseline data. Camel development should understand in line with the government's efforts in changing the livelihood of pastoralists and economic growth at the national level. Focusing camel development means the entering points or the most accessible way to promote the broader pastoral system development.

We are highly committed to bring about a change in the livelihood of society and work with any interested stakeholder who might engage in pastoral development to cooperate with the new camel innovative and integrated approach.

I want to take this opportunity to express my sincere appreciation to the authors who involved in the preparation of this document for their contribution and dedication.

***Ahmed Sheik Mohammed***  
***SoRPARI Director-General***

# Preface

The information on camel research so far done in Ethiopia is very scanty and fragmented. Camel research was done in the field of production, nutrition, health, and little on socioeconomics aspects. However, camel research findings were not widely accessed and/or understood by many people. Consequently, a huge gap between the researchers and academicians, and the livestock keepers and their service providers existed.

This collection of camel research abstracts is prepared to assist researchers, university students, research institutes, and policymakers to have background information on published or documented camel research works on nutrition, production, socioeconomics, and camel diseases in Ethiopia. Camel research abstracts are collected from Haramaya, Jigjiga and Samara Universities, SoRPARI, APARI, EIAR, and ILRI.

The purpose of this book is to collect and compile the camel research conducted in the country and to get more lessons from it. This is an attempt to show the number of camel research conducted in different disciplines for the last three decades, which can help to get detailed information about the current camel research status in Ethiopia. The information provided in this document is therefore meant to contribute towards a better understanding of the basic camel technology/information and availing interventions. Thus, it can serve as an up-to-date camel research reference material for a wide range of actors engaged in teaching and research. It might also help to all researchers not to repeat the research conducted previously and to focus only on new research areas that are not addressed.

In order to narrow, the information gaps it is highly crucial to collect all camel research conducted in different research institutions and universities. Thus, 142 research abstracts collected on camel production (27), camel dairy science (42), camel breeding (7), camel feeding, and nutrition (8), and camel health (58) are collected from Haramaya, Jigjiga and Samara Universities, EIAR and ILRI. This directory is prepared to assist researchers, students, and policymakers to have background information on published and/or documented research works on a camel in Ethiopia. In addition to this, it is helpful not to repeat the research conducted previously and to focus on new research areas that are not addressed.

We are not fully confident that all published camel research abstracts from all the universities and research institutes are collected and this work is not complete as there might be many published articles still available somewhere in the hidden shelves of the university or research institute. We, therefore, kindly request to send the abstracts that not published in this book to the corresponding author to include in the second edition.  
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# Camel Research and Achievements in the Somali Regional State

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The livelihood of pastoralists and Agro-pastoralists of Somali Regional State depend on livestock and livestock production, while livestock production is the primary occupation for the pastoralists, who represent the significant portion of the population in the region. However, livestock production constrained by a shortage of feed caused by frequent droughts, which affected both, feed quality and quantities and this resulted in body weight losses, inability to resist diseases, and damage to animals. Promoting camel husbandry has improved food security for many pastoralists among the other reasons; the challenge was and still is, to provide sustainable services to a society that is continually on the move. It is only very recently that emphasis has given for research in the area of rangeland and pastoral production system

Camels well adapted to the arid climate, and while famine and drought make other livestock species to stop milk secretion and let them even die, camels can continue producing milk. Camels survive in dry areas and produce milk and meat from desert resources. The threats posed by the recurrent and pronounced droughts have awakened pastoralists to pay more attention to camel keeping than ever before leading to the introduction of camels. Camels also prized in their role in traditional social relations such as payment of the bride, wealth, and compensation of injured parties in tribal feuds. Camel is a unique animal, camel milk is very different from the milk of other livestock species, and it is much similar to the human milk, which will make camel milk assume a particular value for human consumptions especially at the time of feeding the orphanage and during a severe drought and famine in the arid region. However, despite these large populations in the system, camel productivity is found to be low due to poor health, nutrition, and management.

Moreover, among the main constraints to pastoral camel production goes to diseases, which are of priority. Similarly, the second serious problem in pastoral areas of SRS limiting camel production is feed shortages, especially during the dry season. Paradoxically enough, despite the multiple functions and roles of camels, there has been minimal emphasis given to camel research and development. Apart from pastoralists, whom their life depends policymakers had neglected the camel, donors, NGO,s, or at least with a relatively small input by different actors which are involving pastoral development compare to other livestock species. Encounters, for instance, any development intervention which might be intended to improve feed resource of a camel could also act as increasing feed resource of all livestock species. Thus, camel development can service an entry point for tackling broader pastoralists' development. Camels classified as browsers with selective behavior and there is no negative environmental impact expected from increasing use of camel. Under this context,

camels are generally considered environmentally friendly and are not associated with environmental degradation.

Along with growing camel milk marketing in urban areas, in recent years, camels which mostly known to graze/browse under extensive system earlier are now facing increasing management problems in urban areas, thus needs a better alternative feeding system which is socially acceptable and economically viable. The principal reasons driving camels to migrate urban areas in recent years are mainly associated with drought frequencies, which affected the cattle population. Consequently, lactating camels is replacing cattle herds formerly dominated urban areas.

Camels in urban areas play a significant role in supplying town dwellers with milk and meat under inferior management, feed shortage, and lack of extensive grazing systems. Sometimes they face hostile conditions with high calf mortality. Recently developed phenomena are still one of the enormous challenges that have not given attention. Under this, context the Intensive grazing system should develop planned to practices, especially along with riverine areas, around town, etc. where lactating camels used as a source of livelihood by milk selling to generate income for newly re-settle pastoralists.

### **Achievement and challenges**

Based on the past research finding I believe such research findings could enable us to design future research for development approach so that to be able to adjust our future policies and strategies in promoting sustainable development of pastoral societies in the relation of camel development. Not enough but the past conducted camel research has generated limited useful information that would assist in building knowledge and skills of camel production. So far, the available information is only limited baseline data rather than ensuring development sustainability in pastoral production systems in general and camel production improvement in particular. Highlights of camel research achievements undertaken in the region by the different organizations are summarized below.

- Some studies on camel diseases and parasites, monitoring of productivity, nutrition, processing of meat and milk, and their socio-economic aspects have done.
- More than 15 MSc theses conducted in the Somali region (Haramaya University) (put the abstract and year done and who did it in the annex).
- Many articles regarding studies on camel undertaken in the region published in international and local institutions. (List these in an annex. It is essential because it builds the image of the national efforts )

Despite these, there has been minimal emphasis given to camel research and development as compared to other livestock species and the size of the problems as well. Therefore, very little work was done in the field of technical knowledge dissemination, information sharing, and transfer of research results.



## Challenges

The challenges realized up to now regarding enhancing camel research and development activities in the region include the following:

- Little emphasis given to camel research & development endeavors so far;
- Climatic problems such as recurrent droughts & high temperatures;
- Scarcity of necessary production system information;
- Nature of the farming system (i.e., Mobile in nature);
- Severe land degradation;
- Difficulty in undertaking sufficient research and development intervention due to lack of attention by policymakers;
- The camel keeping is expanding urban areas in recent years due to drought pressure and voluntary resettlement of pastoralists, but camel in a metropolitan area poorly managed. If the camels were not well managed in urban, they would provide a poor example rather than a good one, thus shedding doubt on the pastoralists future resettlement trends;
- Besides that One of the most significant aspects is how the increasing camel milk production has now been taken up by many people living in urban areas, but one key challenge is facing camel milk consumers include producing pure milk, transporting it and maintaining quality, processing products; and
- Camel feeding behavior requires vast are thus another core challenges which are effecting camel productivity in urban are developing new camel feeding system and management.
- Lack of institution responsible and supporting camel pastoralists development needs with great attention. The recognized camel development challenges include health, rangeland degradation, feed shortage, marketing constraints, husbandry, droughts, conflicts, and animal welfare concerns, changing camel owners attitude through education and creation of awareness and capacity building, improved land use with an effective and efficient form of benefiting government service.

## Transforming challenges to opportunities

The current phenomena in favor of increasing camel in urban areas offer both challenges and opportunities. One of the main opportunities for pastoralist's resettlement is the reduction of poverty, illiterate, and increased education for all children. The expanding camel keeping into the new environment must transform into modern commercial and competitive production and marketing systems through value-addition based on scientific procedures. This will lead to improving camel health and production, enhanced market access, improved product hygiene, and increased awareness and sensitization on camels leading to recognition, acceptance, and use. Moreover, the present trends of re-settled pastoralist's preferences are supported by increasing feed resources along riverine banks due to recently introduced improved forages which adopted under riverine conditions. The newly emerged feed resources are superior to other available feed resources in the pastoral system thus

better quality intensive system method could develop. For existing challenges are multiple. As far as the occurrence of recurrent drought continues, the intensity and magnitude in Pastoralists migration with some of their herds would be anticipated to continue. Because of this, therefore, the leading strategies and development efforts by the SRS should be to build up a food security system through improving camel husbandry, available feed resource management and improving the economy and social integration with the populations in towns are the prerequisites for the continuing the livelihood of newly resettles pastoral in a sustainable manner. If this cannot be achieved, the pastoralists will suffer more where they will join the marginalized and jobless majority populations dominating the towns of Ethiopia pastoralists regions — considering the current state of overall pastoralists system stability in terms of socio-cultural due to among other reasons inappropriate government interventions and frequent drought. It is imperative that the region's development strategy geared towards the attainment of food self-sufficiency with the appropriate emphasis given to the pastoralists system stability and management of the natural resources. In this pastoralist zone, most forage plants are becoming limited, because of the rangeland degradation and overgrazing resulting in a shortage of plants. The problem of traditional camel managed further exacerbated by the frequent drought, feed shortage, rangeland degradation, and expansion of cultivated land. Therefore, there is an urgent need to rehabilitate and restore the degraded rangeland and jointly planned grazing land through appropriate development intervention.

# Part I

# Production



Photo credit: Sisay Tilahun





## **Husbandry and Breeding Practices of Dromedary Camels among Pastoral Communities of Afar and Somali regional states, Ethiopia**

*Yosef T., Mengistu U., Solomon A., Mohammed Y. K., Keefelegn K., and Tadelle D. 2014. Journal of Agriculture and Environment for International Development - JAEID 2014, 108 (2): 167 - 189*

The objectives of this paper were to identify and describe husbandry practices, herd structure, owners' trait preferences, breeding practices, and production constraints of a camel in the two major camel rearing regions of Ethiopia viz. Afar and Somali, to generate baseline information that would help to plan possible breed improvement strategies and options for the different camel populations. The study sites were selected purposively while households from each of the sites randomly. Data were collected using formal questionnaires and focus group discussions. Results showed that the average camel population per household was higher in Mille (28.06±2.27), Gode (27.51±2.02), and Moyale (24.07±2.13) districts. Female camel populations with the age of >1 year contribute 78-83 % of the total camel herd population in all the study districts. The higher number of female animals in the herd in the arid environment means providing a continuous supply of milk and allows a rapid recovery of herd numbers after a disease outbreak or drought occurrence. This shows that pastoralists breeding objectives are in relation to the arid environment and female population in the herd. Most of the pastoral communities utilize a single breeding male camel per 40-50 female camels and this will affect productivity and heterogeneity of the camel population. With regard to trait preference, all pastoral communities ranked milk yield as the first trait of choice, except Moyale district in which adaptation trait was the primary preference. Growth trait ranked second in Mille, Gode, Liben, and Jijiga pastoral communities whereas adaptation trait ranked second in Amibara and Shinile pastoral communities. The major camel production constraints were feed, diseases, and lack of water in that order and the major cause of the constraints was the recurrent drought occurred during the past 2-3 decades in the two regions. Therefore, in planning and implementation of the breeding strategies of the camel population breeding program, besides improving some of the traditional practices, the indigenous knowledge of the pastoralists and trait of choice should be considered in order to effectively increase the productivity and satisfy the need of the pastoralists.

## **Socioeconomic Profile and Gender Characteristics in Relation to Camel Management Practices in the Pastoral Communities of Ethiopia**

*Yosef T., Mengistu U., Kesari P., Mohammed Y. K., Keefelegn K., Solomon A. and Tadelle 2015*

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Pastoralism was one of the oldest forms of organized human society in providing sustainable livelihood opportunities. However, this way of life is increasingly under threat due to a number of reasons. Today's political, legal, social, and economic policies and laws are not taking into consideration the needs of pastoral populations especially women and children. An attempt has been made to evaluate the socio-economic conditions among the pastoral households of Eastern and Southern parts of Ethiopia. The study involved three major pastoral areas of Ethiopia, namely, Somali, Afar, and Oromia regional states. The findings of this study revealed that lacking formal education except for limited religious education for male children, girl children are excluded from any type of literacy. Population size in the study areas reflects above the national average, due to the custom of a polygon. Regionally there has been a

variation in decision making on issues like the intensity of production, breeding, camel herding, milking, marketing, and other related activities. In general, this study observed that there has been a dominant role played by nomic activities. Hence, different types of social and policy interventions should be made.

### **Distribution, Characteristic Features of Camel Populations (*Camelus dromedarius*) and the Unseen Treasures of Rock-Shelters in Relation to Camel Domestication in Ethiopia**

*T. Yosef, Y. K. Mohammed I, U. Mengistu, A. Solomon, K. Kefelegn D. Tadelle 2015.  
Global Journal of Animal Science, Livestock Production and Animal Breeding  
Vol. 3 (3), pp. 145-155, March 2015*

The objectives of the present study were to describe the distribution and characteristic features of Afar and Somali camel populations and to review the history of camel keeping in relation to the findings of camel fossils and paintings in different rock shelters in Ethiopia. Eight camel populations have been identified, of which Amibara and Mille were present in Afar while Jijiga, Shinille, Liben, Gelleb, Hoor, and Aiden were found in Somali regions. The study showed that the Ethiopian camel population has 0.08 of Age at first calving (AFC),  $\pm 0.6$  months and  $1.73 \pm 0.09$  years,  $26.41 \pm$  exhibited on average 4.95 Calving Interval (CI) and Number of Service per Conception (NSC) respectively. The lowest AFC and NSC were observed in the Liben camel population whereas Gode camel populations exhibited the highest AFC and CI. Camels from Jijiga and Gode produced the highest average milk yield in both dry and wet seasons. The prevailing wider range of characteristic features and variation in milk and meat production of Ethiopian camels indicated that their productivity could be improved by implementing the appropriate breeding program through selection. All the relationships of camel rearing for a different purpose (milk meat and draft) and their distinct features in different pastoral communities may indicate that camel keeping in Ethiopia has been many centuries-old traditions. Moreover, the camel paintings and fossils in different rock shelters had an estimated date earlier than the first millennium. Hence, it is plausible to think that camel keeping took place in the Horn before 3000 years.

### **A New Initiative of the Afar Pastoralists of the Awash Valley in Ethiopia for Complementary Food Production**

*Denis Gerard  
Oasian Agriculture and camel harnessed Traction  
J. Nomadic Peoples, number 29, 1991*

This paper attempts to look into the possibility of integrating pastoral crop production in order to consolidate the traditional system of the Afar. The author describes the two programs that have been launched without arresting local initiatives. The first is the consolidation of a newly emerging agricultural system and its introduction to Oasian agriculture. The idea here is the introduction of small irrigated farms that would lead to the intensification of production and be a complementary activity to the Afar traditional animal husbandry system. The second is the harnessing of the camel and the introduction of traction in order to facilitate soil tiling. The author, who introduced camel harnessed traction among the Afar, argues that the camel is a good alternative to tractors for two reasons: 1) there is local knowledge on how to take care of camels 2) camels are adapted to the environment.

## **Potential of Camel Production in Babile and Kebribeyaha of the Jigjiga Zone, Somali Region, Ethiopia**

*Yohannes Mehari, Zeleke Mekuriaw, and Getachew Gebru  
Livestock Research for Rural Development 19 (4) 2007*

The study was conducted from July 2005 to January 2006 in Babilie and Kebribeyah woredas, Jigjiga Zone of the Somali Regional State with the objective of identifying the production potential of the camel in the study areas. The method of data collection employed was a single visit formal survey. The biological and social variables considered were milk production, body weight, and draught power of camel. The data was analyzed using Statistical Package for Social Sciences (SPSS) version 12. In the present study, the majority of respondents (67.5 and 65% for Babile and Kebribeyah, respectively) indicated the lactation length of camels to be 12 months. There was no significant difference ( $p>0.05$ ) across woredas for the frequency of milking for mid and late stages of lactation, in the wet season. However, significantly difference ( $p < 0.05$ ) in milking frequency in the early stages of lactation and in the dry season was recorded. There was a highly significant difference ( $p<0.01$ ) for the estimated mean daily milk yield between the two woredas at an early stage of lactation. In general, the mean daily milk yield was higher during the wet season than the dry season for both woredas. The mean linear body measurement for male and female camels was compared. The data revealed that abdominal girth, chest girth in front of breast pad, and chest girth behind breast pad were not significant ( $p>0.05$ ) but there was a significant difference ( $p<0.05$ ) in height between sexes. The regular and occasional type of work of camels in the study area was packing, transportation, plowing, and traction. The existence of a wealth of indigenous knowledge for treating different Human and animal diseases was identified in this study.

## **Camel Production and Productivity in Eastern Low Lands of Ethiopia Livestock in Food Security—Roles and Contributions**

*Bekele Tafesse and Kebebew Tuffa 2001. In: Proc. of 9<sup>th</sup> Annual Conference  
Ethiopian Society of Animal Production*

The one-humped camel (*Camelus dromedarius*) plays a significant role as a primary source of subsistence in the lowlands of the country. The Somali, Afar, and Borana are the main ethnic groups involved in camel husbandry in the nation. The calf managed traditional from birth to weaning age. The weaning age varies from 8-18 months. After weaning if male fails to get selected as future sire then it serves as a pack animal or slaughtered and females are kept as dairy animals. The watering and grazing management of camels is influenced by the habitat of camels. Based on the preference of camel the most important plant browsed by camels is *Acacia brevispica*, *Opuntia Vulgaris*, and *Dichrostachys ciniarea*. Camels are supplied with salt and traditional mineral water. Ogaden camels are watered every 10-15 days if the water source is nearby. But during the rainy season camels may not drink water for 1-2 months. Reproductive performance exerts a major influence on the productivity of milking animals. The age at puberty for the male is around four years but is first allowed to breed at the age of five. The average age at first calving is six years and one female may produce up to eight calves in her total production life. The rutting season is associated with the availability of ample browse and usually, it appears around the end of the rainy season. In the study area, one bull is selected for a herd of the camel which may serve satisfactorily 40-100 females. Calving rate, gestation length, days open, and calving interval are recorded to be 40-50%, 350-390, 199, and 573 days, respectively. Camel produces more milk for a longer period than other species of animals maintained in drylands. The milk yield per day in eastern Ethiopia varies from 3-10kg, with a

lactation yield of 1244-2104 kg and a lactation length of 9-14 months. Camel serves as an important means of transportation in the drylands of eastern Ethiopia and they are used for traction for the last 25 years. They select camel at the age of four and a half years and train in the village. Only a male camel is used for packing. Camels are slaughtered on a daily bases for household consumption. In Jigjiga camel supplies around 164,506-kg meat, each year and the per capita consumption in the same town is 0.5 kg/year. The dressing percentage was 52 %. The bodyweight of the Ogaden camel type is 612, 463, and 129, for mature male, mature female, and a year-old calf respectively. The mean calculated live weight for adult male and female camels was 486 kg and 427 kg and 384 kg and 326 kg for Jigjiga and Shinile respectively. Camel hide and hair are not much utilized but in some areas, it is used to prepare carpets and suturing thread for making shoes.

## **Effect of Different Weaning Age and Supplementation of Concentrates on Post Weaning Performance of Camel Calves at Errer Valley, Eastern Ethiopia**

*Merga Baissa. 2011. M.Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

This experiment was conducted at Errer Valley camel research station, eastern Hararghie zone from August 2008–August 2009. The objective of the study was to investigate practical weaning age and the effect of supplementation of concentrate ration on the post-weaning performance of camel calves. A total of 20 (9 females and 11 male) camel calves of 2 to 6 months of age at the start of the experiment were used. The treatments were weaning at 6(T<sub>1</sub>), 8(T<sub>2</sub>), 10(T<sub>3</sub>), and 12(T<sub>4</sub>) months of age. Treatments T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> were supplemented with concentrate consisting of a mixture of 60% wheat bran and 40% noug seed cake at a rate of 1.6 kg DM per 100 kg body weight after weaning at the respective age up to 12 months of age. Average daily weight gain (ADWG), milk consumption by weigh–suckle–weigh method to weaning age, milk offtake to 12 months of lactation, and mortality up to 14 months were recorded. The mean concentrate consumed by the supplemented camel calves in T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> were 1.61, 1.62, and 1.55 kg per day, and no significant ( $P>0.05$ ) difference was observed among the treatments. Concentrate consumption was significantly ( $P<0.001$ ) higher in the dry season ( $1.83 \pm 0.03$  kg/day) than in the wet season ( $1.36 \pm 0.04$  kg/day). Overall mean post-weaning ADWG was significantly ( $P<0.001$ ) higher for T<sub>2</sub> ( $0.359 \pm 0.012$  kg) as compared to T<sub>3</sub> ( $0.267 \pm 0.016$  kg) and T<sub>4</sub> ( $0.215 \pm 0.009$ kg). No difference was observed between T<sub>1</sub> and T<sub>2</sub>, but T<sub>4</sub> is significantly lower than the other treatments. ADWG at 14 months of age were significantly ( $P< 0.001$ ) higher for female ( $0.319 \pm 0.13$  kg/day) than male ( $0.255 \pm 0.008$  kg/day) camel calves. ADWG was significantly higher ( $P>0.001$ ) for the main rainy season ( $0.359 \pm 0.15$  kg) followed by the short dry ( $0.278 \pm 0.016$  kg) long dry ( $0.264 \pm 0.078$  kg) and the short rainy season ( $0.248 \pm 0.010$  kg). Average morning milk consumption estimated by weigh–suckle–weigh method for the calves to weaning age of 6 ( $1.05 \pm 0.15$  kg/day) and 10 ( $1.18 \pm 0.06$  kg/day) months were significantly ( $P<0.05$ ) higher than milk consumption to weaning age of 8 ( $0.88 \pm 0.07$  kg/day) and 12 ( $0.91 \pm 0.06$  kg/day) months of age. Milk consumed by the calves was higher ( $P< 0.05$ ) in the wet season than the long dry and short dry seasons of the experiment. Over the mean milk offtake recorded for the dams of the experimental calves was 2.3 l/day. Mean milk offtake was significant ( $P< 0.001$ ) in the order  $T_2=T_1=T_4>T_3$ . Helminthes parasites, mange mite, and respiratory diseases were prevalent during the wet and the dry season of the experiment, however, their prevalence was higher ( $p<0.05$ ) during the rainy months than during the dry months. The highest prevalence (86%) and egg per gram (EPG) of faeces ( $2884 \pm 0.26$ ) were observed in May and August (rainy month), whereas the least prevalence (62%) and EPG of faeces ( $941 \pm 0.23$ ) were recorded in November and



February (dry month). However, prevalence and fecal mean egg count were similar ( $P>0.05$ ) between treatments and calf sex. The mean larvae count of five types of parasites identified in November were relatively higher for T<sub>1</sub> (55.55%) followed by T<sub>3</sub> (54.17%), T<sub>2</sub> (37.5%), and T<sub>4</sub> (25%), respectively. The helminths parasites identified were *Haemonchus* spp, *Trichostrongylus* spp, *Strongyloides* spp, *Nematodirus* spp, and *Trichuris* spp with a prevalence of 80%, 80%, 73.33%, 6.67%, 6.67%, and 6.67%, respectively. During the experimental period, mortality was higher in T<sub>3</sub> and T<sub>4</sub> with 40 and 20%, respectively. This indicates that the later the age of the weaning the lesser the survivability of the calves.

## **An Assessment of the Productivity for Meat and the Carcass Yield of Camels (*Camelus dromedarius*) and the Consumption of Camel Meat in the Eastern Region of Ethiopia**

*Kurtu, M. Y. 2004. Trop. Anim. Hlth. and Prod. 36: 65-70*

A survey on camel meat productivity and consumption was conducted in Jigjiga and Harar towns in 1999. Almost all the camels slaughtered were adults, predominantly males. Measurements of height, hump girth, and thoracic girth were used to estimate the live weight. All the measurements were significantly greater in the male than in the female camels. Average live and carcass weights were 400 and 211 kg, respectively. Males were significantly heavier ( $p < 0.05$ ) and had better dressing percentages than females. The carcasses contained averages of 76% meat, 12% fat, and 20% bone for both males and females. The difference between the males and females was not significant for the ratio of meat and bones, except for fat, which was higher in the males. Camel meat is regarded as a high-quality food with medicinal value and as a least-cost source of meat. Camel meat is preferred to that of any other livestock by some people, particularly by the Somalis in Jigjiga town. It is also more available, especially during the dry season when beef is in short supply. Hence, camel meat is a socially acceptable, economically viable, and environmentally adaptable alternative source of meat, consumption of which should be encouraged.

## **Camel Marketing in Eastern Ethiopia**

*Tezera Getahun and Bekele Tafesse 1998 In: Proc. of 6<sup>th</sup> Annual Conference Ethiopian Society of Animal Production (ESAP), 141-25 May 2003. Addis Ababa, Ethiopia pp.194-200.*

Camel marketing was studied in the drylands of Eastern Ethiopia. The data was obtained from the South East Rangelands Development Project (SERP) in Dagahabour, Jigjiga, and Babile livestock marketing sites. The data were collected during market days from 1991 – 1993 to understand the extent and patterns of camel supply and demand as well as camel prices and trends. The Dagahabour market site, surrounded by camel dominated areas, was the leading in supply and sale of camels which accounted for 53% and 60% of the total supplied ( $N = 73,032$ ) and sold ( $N = 22,790$ ) camels, respectively. The total camels sold were 31% of the total camels brought to all markets of which the male camels accounted for 69%. Camels were observed in excess during drier months, November – February, and June to July. The average price was birr 754 for male camels and 573 for females. Special attention should be given in the development and improvement of camel marketing to render possible ways to absorb the surplus camels from the markets. Indeed, the improvement of livestock marketing, in general, can be reflected by the betterment of the livelihood of the animal farming societies of eastern Ethiopia.

## **Growth Rate of the One-Humped Camel in Semi-Nomadic Households in Errer Valley Eastern Ethiopia**

*Bekele, T. and Zeleke, M. 2001. Trop. Agric. (Trinidad) Vol.78 No. 3 pp. 206-210.*

Productivity aspects of camels (*Camelus dromedaries*) kept under pastoral management conditions at Errer Valley Ethiopia, were monitored from October 1997- December 1999. Female immature camels (1-4 years old) showed significantly ( $P < 0.01$ ) higher daily weight gain ( $59.40 \pm 0.61$ g) than males of the same age ( $33.24 \pm 0.50$ g/day). Furthermore, significantly ( $P < 0.05$ ) higher daily weight gain ( $63.12 \pm 0.45$ g) was recorded for camels of 1-3 years than camels of 3-4 years of age ( $29.52 \pm 0.54$ g). Likewise, a significantly ( $P < 0.05$ ) higher daily weight gain ( $50.68 \pm 0.54$ g) was observed during the wet season than during dry season ( $41.96 \pm 0.54$ g per day). The average annual herd growth and commercial animal offtake rate (total number of animals sold within a year + the average number of animals within that year  $\times$  100) of the monitored camels were 10.66% and 4.65%, respectively. More than 77.3% of the camels sold were males and old females. The annual mortality rate of the camel herd was 11.8 % (14). The mortality rate of calves below one year was higher than the mortality rates of immature camels and adults. From this study, it can be concluded that better management to overcome respiratory problems and gastroenteritis problems during calf-hood and better feeding strategy during the dry season can enhance the herd and individual growth rate.

## **Traditional Feeding Management, Drought and Migration of the Camel Herds of Afer Zone, Somali Regional State, Ethiopia**

*Ahmed Sheik, M., Asefa Asmare, A., Hegde, B.P. and Ahmed Bashir, D. 2004*

*In: Proceeding. of 12<sup>th</sup> Annual Conference Ethiopian Society of Animal Production (ESAP), 12-14 August 2004. Addis Ababa, Ethiopia, pp. 125-136*

This study was initiated with the objectives of generating baseline data in the area of traditional feeding management, drought, and migration of the camel herds. The study was undertaken in the five purposely selected Woredas of Afer zone. Sampling methods used were stratified random sampling technique where each Woreda was classified into small (10 – 20 camels), medium (21-50 camels), and large (>50 camels) herders were considered. The study revealed that traditional feeding management practices by camel owners. During grazing, particularly in the dry season, camels were found to cover large areas 8, 10, 9 km for small, medium, and large herds respectively. The El-Kari herds covered the least distance compared to other Woredas ( $P \leq 0.05$ ). During the drought, they crossed national and international boundaries. All camels irrespective of herd size and woreda ( $P \leq 0.05$ ) grazed for 5.3 to 5.7 hours before noon. The mean intervals between grazing were two hours. Salt sources of the study area were saltwater, salty plants, and salt itself. Salt feeding is commonly practiced during the early dry season or late wet season. The mean water intake of an adult camel was found to be 126-140 liters at first pause and 49-55 liters at the second pause. The mean watering intervals were 6.7-7.2 ys during the dry season and the watering interval of the wet season varied from one to two months. El-Kari herd owners offered water at the longer interval ( $P \leq 0.05$ ) than the rest and these camels took more water during the second pause ( $P \leq 0.05$ ). It was noticed that the longer the watering interval the greater was the water intake in the first pause ( $P \leq 0.05$ ). It was observed that adult camels could survive without water 44.6 days. The mean feed deprivation tolerance was 31-39 days. During drought, camels were the last species to be taken to market.

## **Costs and Returns of Camels, Cattle and Small Ruminants in Pastoral Herds of Eastern Ethiopia**

Baars, R.M.T. 1998. In: *Proc. of 6<sup>th</sup> annual conf. Ethiopian Society of Animal Production (ESAP), 14-25 May 1998. Addis Ababa, Ethiopia. pp. 162-175.*

Two questionnaire surveys were conducted to analyze the costs and returns of camel's cattle and small ruminants in pastoral herds in eastern Ethiopia. In each survey, 44 small pastoral households having camels in 3 grazing management systems in 4 regions were randomly interviewed. Among them, only three households had no cattle or small ruminants. The average number of tropical livestock Units (250 kg) was 4.0 per household member. Milk production was the most important revenue (66% of total revenue) followed by the sale of livestock (17%) and transport. The income derived from local slaughter was (1%) and hides (+ 0%) were significant. High mortality rates were recorded for all livestock species. Ten percent of the milk was converted into butter. The sales price of butter was very low compared to fresh milk. About 25% of the milk was sold fresh or as butter, but nomads rarely sold milk. Sedentary and transhumant grazing management systems showed similar levels of income, whereas nomads had a 2.4- fold higher overall income. The average total gross income of the entire herd amounted to Birr 38684 per household per year. The contribution to the total gross revenue of camels, cattle, and small ruminants was 60%, 24%, and 16%, respectively. The calculated costs were 30% of the gross return.

## **Productivity, reproductively and Health Monitoring Study on Camel Herd in Error valley, Ethiopia**

*Zelege Mekuriaw. 1998. M.Sc.Thesis, Haramaya University, Dire Dawa, Ethiopia*

Productivity, reproductively and Health aspect of Camels (*Camelus dromedarius*) kept under pastoral management conditions at Error Valley, Ethiopia were monitored for a year (October 1997-September 1998). Milk offtake, weight gain, herd growth rate, animal offtake, and mortality were assessed. The reproductive potential of the camels such as annual calving percentage, service per conception interval between birth and conception, and abortion were looked into. The prevalence and seasonal dynamics of trypanosomiasis, mange mites, strongyle parasites, and ticks were identified. A serological test against brucellosis was also undertaken. The outbreaks of some other diseases were visually assessed. Milk offtake was significantly higher ( $P<0.01$ ) during the wet season than during dry season (1.49 liters). Significantly higher ( $P<0.01$ ) milk off-take was recorded from camels of parities 1-4 (3.03Lt) than camels of parities 5 and above (1.58 liters). Furthermore, significantly higher ( $P<0.01$ ) daily weight gain (63.12 grams) was recorded from camels of 1-3 years old than camels of 3-4 years old (29.52 grams). Likewise, significantly higher ( $P<0.05$ ) daily weight gain (50.68 grams) was observed during the wet season than during dry season (41.96 grams). The annual commercial animal offtake and herd growth rate of camels were 4.47% and 8 .91%, respectively. The mortality rate of camels below one was higher than those of immature and adult camels. Most of the mating and calving of camels were during the rainy months of the year. The annual calving percentage, number of services per conception, open days, and abortion rates for the monitored camel herd was 42.7%,  $1.4\pm 0.1$ ,  $162.8\pm 7.9$  days, and 12.1%, respectively. Trypanosomiasis, mange mite lesions, strongyle parasites, and ticks were prevalent throughout the year. However, their prevalence rates were higher during rainy months than during dry months of the study period. The trypanosome species identified was *Trypanosoma evansi*. Its minimum and the maximum point prevalence rate was 5.41% and 20.59% respectively. Similarly, the point prevalence rate of mange mite infection was also varied from 4.67% (during the dry month) to 21.70% (during

the year, respectively). The highest strongyle eggs per gram of faeces (1036, 05Y0.65) and highest point prevalence rates (85.71%) were observed in October (rainy month) whereas the least eggs per gram of faeces (358.83Y0.62) and least point prevalence rates (61.54%) were recorded in April (dry month). From 15284 ticks collected, 11 tick species were identified. Of these, *Rhipicephalus pulchellus* (87.36%), *Amblyomma gemma* (4.10%), *Hyalomma dromedary* (3.87%), and *Amblyomma Variegatum* (3.21%) were the most abundantly found tick species of monitored camels. The highest tick load per camel (105.34Y0.55) was observed in August (rainy month) whereas the least (27.81Y0.54) was in December (end of the rainy month). The prevalence of brucellosis was very low (1.67%). An outbreak of camelpox and a new respiratory disease was encountered during the monitoring period. Despite higher prevalence rates of Trypanosomiasis, mange mites, strongylosis, and external parasite, the higher milk off-take and growth rate, percentage of conceptions, and calving were noticed during the rainy season. Due emphasis to reduce the health constraints during the rainy season and to increase the availability of feed and water during dry season should be the twin objective of any improvement program on camels of this region.

## **Study on Practices and Problems of Camel Production in Afeder Zone of Somali National Regional State, Ethiopia**

*Ahmed Shek Mohamed. 2002. M.Sc.Thesis, Haramaya University, Dire Dawa, Ethiopia*

Camel management practice, Productivity, and camel production constraints were studied in the Afder zone of the Somali region, Ethiopia. A systematic random sampling technique was used. The herds were classified into small (10 – 20heads), medium (21 – 50 heads), and large (more than 50 heads). For each Woreda, five herds of each heard group were randomly sampled in five selected Woreda. The study revealed that there are two types of dromedary camels namely Hoor, considered as milk type and Gel-lab considered as multi-purpose camels. Women participated in camel husbandry practices, particularly in the selling of milk and looking after the packing male camels. There was a general trend of large families possessing large herds. To increase camel herd size bartering of sheep and goats was practiced. In all age groups number of female camels was higher than that of males indicating the importance of milk production and reproduction in the arid area. During grazing particularly during the dry season, camels were found to cover a large area (8, 10, 9 km for small, medium, and large herds respectively). The El-kart herds covered the least distance compared to other Woredas ( $P \leq 0.05$ ). During drought, they crossed national and international boundaries. All the camels irrespective of herd size and Woreda ( $P \leq 0.05$ ) grazed for 5.3 to 5.7 hours before noon. The overall mean interval between the grazing was two hours. Salt sources of the study area were saltwater, salty plant, and the soil itself. Salt feeding is commonly practiced during the early dry season or late wet season. The mean water intake of the adult camel was found to be 126-140 liters of first pause and 49-55 liters at the second pause. The mean watering intervals were 6.7-7.2 days during the dry season and the watering interval of the wet season varied from one to two months. El-Kari herd owners offered water at the longer interval ( $P \leq 0.05$ ) than the rest and these camels took more water during the second pause ( $P \leq 0.05$ ). It was noticed that the longer the watering interval the greater was the water intake in the first pause ( $P \leq 0.05$ ). It was observed that adult camels could survive without water for one to two months, particularly during the wet season. During drought, camels were the last species to be taken to market. It was reported that first breeding age was 3.9 to 4.5 years; estrus duration was 6.6 to 7.5 days; gestation length was 12.7 to 12.8 months; age of first calving was 5 to 5.4 years; postpartum anoestrus period was 7-9 days; calving interval was 23 to 24 months. Regardless the herd size and Woreda. The overall average of some parameters of traditionally managed bulls was

reported to be 5.5 years for age at first service, seven years for sexual maturity, 10 services per day (including the night) and a single bull can successively serve 60 to 67 she-camels in a breeding season. Herders were aware of the importance of colostrum feeding, but at the same time, they restricted the quantity of colostrum to calves in all the herders and Woreda because they consider that overfeeding causes death and consequently high loss of calves was observed. High calf mortality was encountered during the first 3 months in general and the most critical period was said to be the first 7 days after birth. Camels were identified with clan and herders' brands on the neck and different clan has different brands and symbols. The Milk yield per day at early lactation for the Hoor sub-type was 2.9 liters compared to that of Gel-lab of 1.8 liters, while during peak lactation, yields were 5.5 liters for Hoor and 3.4 liters for Gel-lab. Dollo-Bay herders milked Hoor type more frequently compared to those of other Woredas ( $P \leq 0.05$ ) and small herders extracted more milk ( $P \leq 0.05$ ) compared to medium and large herders. The result of this study indicated that the average shelf life of soured milk was 3-6 days and excess milk was soured mostly during the wet season. Camels were the main means of transport in the study area and carry a load with a range of 86-221.4 kg depending on the age and the condition of the animal. Aged and culled camels were normally slaughtered and on religious/culture occasions young camels of 3-5 years of age were slaughtered. Olobutter-fried meat is commonly processed meat. The Dareerin is sun-dried meat usually prepared in anticipation of the death of camels due to drought and diseases. The camel production constraints as identified by pastoralists were diseases, feed shortage, labor shortage, camel marketing problems, predators, and conflicts. The disease was found to be the top problem and causes serious economic loss. The role of a camel as a mother of pastoralists and ship of the desert is very true for the Afder zone and not likely to be replaced in the near future. It is up to the government, non-government organizations, and the researchers to ensure that this wonderful animal retains and enhances its utility for future generations.

## **Reproduction, Breeding and Management of Female and Male Camels in Afder Zone of Somali Regional State, Ethiopia**

*Ahmed Shek, M., Hegde, B.P., and Asefa Asmare, A. 2004. In: Proc. of 12<sup>th</sup> annual conf. Ethiopian Society of Animal Production (ESAP), 12-14 August 1998 Addis Ababa, Ethiopia. pp. 175-184*

This study was initiated with the objectives of generating baseline information in the area of traditional reproduction management, breeding females, and bulls of the camel herds. The study was undertaken in the five purposely-selected Woredas of the Afder zone. Stratified random sampling technique was used to classify camel herder's in each Wored's according to camel number into small herd owner (10 – 20 camels), medium herd owner (21-50 camels) and large herd owner (>50 camels). The study revealed that in all age groups, the number of female camels was higher than that of males indicating the importance of milk production and reproduction in the arid area. According to herd owners responses the first age of breeding was 3.9 to 4.5 years; estrus duration was 6.6 to 7.5 days; gestation length was 12.7 to 12.8 months; the age of first calving was 5 to 5.4 years; post-partum anoestrus period was 7 to 9 days; calving interval was 23 to 24 months regardless the herd size and Woreda. Traditionally managed bulls were reported to reach the age at first service at 5.5 years; sexual maturity at 7 years of age; a capacity 10 services per day (including the night), and also successfully mate/serve 60 to 67 she-camels in a breeding season.

## **Production Potential of Camels (*Camelus dromedarius*) Under Pastoral and Agro-Pastoral Systems in North Afar, Ethiopia**

*Tekle, T., and Tesfaye, Y. 2013 Livestock Research for Rural Development (LRRD) 25 (12) 2013*

Milk and meat production potential of the one-humped camel kept under pastoral and agro-pastoral production systems of Ab'Ala woreda, north Afar was assessed during the period August 2008 to January 2009. Randomly selected eighteen agro-pastoral and twenty pastoral households were involved in the study represented by two kebeles from each production system. Daily milk offtake of 296 camels and linear body measurements on 173 camels were recorded using six to nine randomly selected camels belonging to the selected households. The average daily milk offtake from camels in the woreda was 6 liters. Daily milk offtake varied with the production system and season. The mean daily milk offtake was 5.8 liters and 6.2 liters in the agro-pastoral and pastoral system respectively. The estimated mean body weight was 292 kg in males and 320 kg in females. Male and female camels belonging to the agro-pastoral area were heavier than camels in the pastoral system. The meat production potential was estimated to be 149-155 kg and 154-178 kg for adult female and male camels, respectively. Meat production was better in camels from the agro-pastoral origin than pastoral camels.

## **The Status and Major Constraints of the Production and Marketing of Camel in Babilie and Kebribeya Woreda of Jigjiga zone, Ethiopia**

*Yohannes Mehari. 2006 MSc Thesis, Haramaya University, Dire Dawa, Ethiopia*

The study was conducted in Babilie and Kebribeyah woredas, Jigjiga Zone of the Somali Regional State with the objectives of identifying the production potential, the socioeconomic value of camels and to examine the existing marketing situation of camel and camel products in the study area. The methods of data collection employed a single-visit-formal survey. The biological and social variables considered were milk production, body weight, herd structure, draught power, reproductive performance, marketing, and constraints to camel production. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 12. The main age at first mating for male and female camels was 5.8 and 5.0 for Kebribeyah woredas, respectively. The mean linear body measurement of camels was compared with age. It was found that the abdominal girth, chest girth in front of breast pad, and height ht was not significantly different ( $P > 0.005$ ) between different age groups of camels but chest girth behind breast pad was significantly higher ( $P < 0.005$ ) in 13 than in 18 years of age. The mean live weight of camels for Babilie woreda was 435.2 and 378 kg for mature male and female camels, respectively, whereas in Kebribeyah it was found to be 403.3 and 402 kg for mature male and female camels, respectively. In the present study, the majority of respondents indicated the lactation length of camels to be 12 months. Meat production potential of a camel was found to be 230.02 – 240.28 kg for males and 187.74 – 195.14 kg for females in Babilie woreda, respectively, whereas in Kebribeyah it was found to be 214.77 - 225.03 kg for male and 199.76 - 207.16 kg for female, respectively. The regular and occasional types of work of camels in the study area were packing, transportation, ploughing, and traction. The analysis of variance (ANOVA) of the paired sample t-test for age, average selling price, and the number of camels sold and bought indicated the existence of significant difference ( $P < 0.01$ ) between the age of camels sold and bought and that of the average price of camels sold and bought. There was significant difference ( $P < 0.05$ ) for camel numbers sold and bought also. All respondents from Babilie and Kebribeyah woreda were agro-pastoralists, and migration is common to all. Migration places were different between and within woreda. The ownership right for camels in

Kebrebeyah woreda for both males and females, whereas for Babilie woreda the ownership right goes to the male-only. The number of camels for dowry depends on the wealth status of parents. Fertility problems, disease, lack of veterinary service, deforestation, and lack of water were the major constraints camel production in these areas. Lack of mineral water, marketing problems, conflicts, and drought problems were found to be minor problems. No savings and credit service were available in both woredas. The existence of a wealth of indigenous knowledge for treating different diseases was identified in this study.

### **Analysis on the Contributions of and Constraints to Camel Production in Shinile and Jigjiga Zones, Eastern Ethiopia**

*Eyassu Seifu. 2009. Journal of Agriculture and Environment for International Development. 103 (3): 213-224*

Contributions of the dromedary camel and constraints to camel production in Jigjiga and Shinile zones of eastern Ethiopia were assessed. A total of 73 households' were interviewed on the significance of the dromedary camel and constraints associated with camel production in the area using a single-visit-multiple-subject diagnostic survey. All the households interviewed owned camels and milk production was the primary reason for keeping camels in the area. The major contributions rendered by dromedary camels in the study area were milk production and transportation, while the major constraints associated with camel production in the area were feed shortage and prevalence of the disease. Camels in these areas feed mainly on poor-quality natural vegetation. Cactus and acacia were the dominant plant species consumed by camels in the area. Camels were not given supplementary feed except salt and/or mineral soil.

### **Camel and Camel Product Marketing in Babilie and Kebribeyah Woredas of the Jigjiga Zone Somali Region, Ethiopia**

*Yohannes Mehari, Zeleke Mekuriaw, and Getachew Gebru 2007. Livestock Research for Rural Development (LRRD), 19 (4) 2007*

The study was conducted between July 2005 and January 2006. The objective of this study was to examine the existing marketing situation of camel and camel products in the study areas, Babilie and Kebribeyah woredas, Jigjiga Zone of the Somali Regional State. The method of data collection employed was a single visit formal survey. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 12. The traditional markets are used for the sale of animals for slaughter, and the sale of male camels for pack use. The mean numbers of camels sold per household during the year 2004/05 were 1.48 and 1.27 for Babilie and Kebribeyah, respectively, while, the mean numbers of camels bought were 2.40 and 3.14 in the same order. The mean age of camels sold during the year 2004/05 was 79.90 and 84.80 months for Babilie and Kebribeyah, respectively. In the same year, the mean age of camels bought was 29.20 and 24.00 months for Babilie and Kebribeyah, respectively. The average selling price of camels during the survey year was 2011.36 and 1784.38 birr for Babilie and Kebribeyah, respectively. In the same year, the average price of bought camels was 1690.00 and 671.00 birr for Babilie and Kebribeyah, respectively. Respondents (35 and 3.3% in Babilie and Kebribeyah, respectively), reported that camel selling time was during festivals. The main reason for selling camels was family cash need to purchase their basic needs. In the study areas, there is a customary of selling larger sized, old, and unproductive camels. According to the Ethiopian Customs Authority, 726 live camels were exported to Jordan in 2005 only. Most farmers in Babilie sell camel milk either at Bombas or Babilie town. For Kebribeyah pastoralists, Kebribeyah and Hartisheik towns, and open-air collection centers are camel milk selling places.

There was a significant difference ( $p < 0.01$ ) in the volume of camel milk sold in both seasons between Babilie and Kebribeyah woredas.

## **Defining Weaning Age of Camel Calves in Eastern Ethiopia**

*Merga, B. C., Yesihak, Y. M., Mohamed Y. K. and Mengistu U. L. 2014.  
J. of Springerplus, 2014, 3: 313*

This experiment was conducted with the aim to define the weaning age of camel calves managed with pastoral farmers in eastern Ethiopia. Twenty camel calves (11 males and 9 females) were randomly assigned into five blocks based on their birth date. Calves within a block were further assigned to one of the four Treatments (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>). Calves in T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> were weaned at 6, 8, and 10 months of age and supplemented with concentrate from weaning up to 12 months of age, respectively. They were supplemented with a mixture of noug seed (*Guizotia abyssinica*) cake and wheat bran at a ratio of 40% and 60%, respectively. Calves in T<sub>4</sub> (control) were weaned at 12 months of age, hence were not supplemented with concentrate. Calves in all treatment groups browsed natural vegetation for 8 hours a day. The post-weaning performance was evaluated for all calves at 14 months of age. The mean daily concentrate intake was significantly higher ( $P < 0.001$ ) in the dry season compared to the wet season. Daily weight gain was significantly ( $P < 0.001$ ) affected by treatment, sex of calves, and season of birth. Calves supplemented with concentrate gained relatively more weight ( $P < 0.001$ ) than calves not supplemented. Calves born during the short rainy season gained more weight than those born during the short and long dry season. Three calves died, two from T<sub>3</sub> and one from T<sub>4</sub>.

## **Camel Management as an Adaptive Strategy to Climate Change by Pastoralists in Southern Ethiopia**

*Galma Wako, Menfese Tadesse and Ayana Angassa Ecological Processes 2017  
<https://doi.org/10.1186/s13717-017-0093-5>*

Experiences of low rainfall and frequent droughts have had enormous impacts on livestock production and pastoralists' livelihoods in southern Ethiopia. The Borana pastoralists are dependent on livestock husbandry with the dominance of cattle in their herds for generations. Recently, the Borana communities have engaged in extensive livestock species diversification, with more focus on camel management as an adaptation strategy to the severity of recurrent droughts. Although increasing interests in camel management among the Borana pastoralists are acknowledged, the driving forces for the increase in the camel population in the region have not been addressed. The aim of this study was to assess the trend in camel management as an adaptation strategy towards climate change among the Borana pastoral households. The study also investigated evidence of climate change and the driving factors for camel adoption.

## **Effect of Age and Body Condition on Slaughter Characteristics of Dromedary Camels (*Camelus dromedarius*) in Eastern Ethiopia**

*Ali Seid, Mohammed Yusuf Kurtu, and Mengistu Urge.  
2016 Journal of Camelid Science 2016 Vol.9 pp.35-53 ref.34*

A study was conducted to investigate the effect of age and body condition on slaughter yield characteristics of Issa-Somali camels. One-hundred and forty camels were divided into 3 age groups: 18 years). Each age group was then divided into group 1 (6-10 years), group 2 (11-17 years), and group 3 ( into a further three sub-groups according to the body condition score



(BCS) of camels. These sub-groups were poor, medium, and good. Age, BCS, live weight (LW), and weight of carcass and non-carcass components were determined by dentition, notations on fat status, linear body measurements, and weighing using a hanging scale, respectively. The mean slaughter LW was 334.7 kg. The weight of hot carcass (HCW), edible non-carcass product yield (ENPY), inedible non-carcass product yield (INPY), total consumable product yield (TCPY), and total slaughter weight (TSW) were 186.4, 28.9, 110.7, 215.3, and 326.0 kg, respectively. The dressing-out percentage was 55.5% implying camels as producers of the high proportion of meat under extensive management. The LW, HCW, ENPY, INPY, TCPY, and TSW significantly ( $P < 0.05$ ). Heart and lung were not affected ( $P > 0.05$ ) by age and BCS. The yield components significantly and positively correlated with each other and to LW. The thoracic girth was the most reliable predictor of LW and yield components in regression equations. Camels of 11-17-year-old from medium body condition had the optimum slaughter characteristics compared to other groups. Options should be sought to utilize and add value to INPY that comprised 33.1% of LW of the camel.

### **Slaughter Practices and Composition of Dromedary Camel (*Camelus dromedarius*) Meat in Relation to Age and Body Condition in Eastern Ethiopia**

*Ali Seid, Mohammed Yusuf Kurtu, and Mengistu Urge 2017. Journal of Agriculture and Environment for International Development. 2017 111.597*

This study was conducted to monitor the camel slaughtering practices, and evaluate meat composition in relation to age and body condition of camels. Fifty-four male Issa type camels of three age groups: group 1 (6-10-year-old), group 2 (11-17-year-old) and group 3 ( $\geq 18$ -year-old) where each age group classified to three body condition groups (poor, medium and good) were sampled from camels slaughtered in one of the abattoirs in eastern Ethiopia. The camels were monitored for slaughtering practices and their meat compositions were investigated following standard procedures. The results showed that camels were slaughtered inhumanly violating many of the basic requirements of humane and halal (permitted) slaughtering, including cruelly cutting Achilles tendon of hindlegs, severing the neck with more than one stroke, and sharpening knives and performing slaughtering in front of camels waiting for slaughter. Muscle, bone, and fat proportions were 54.9, 25.5, and 19.6%, respectively. Proportions of muscle ( $P < 0.0008$ ) and bone ( $P < 0.004$ ) decreased, but fat ( $P < 0.0001$ ) increased with age and body condition. The moisture, ash, crude protein (CP), and lipid contents were 78.3, 2, 20.14, and 9.45%, respectively. The ash ( $P < 0.0074$ ) decreased and lipid ( $P < 0.05$ ) increased with age. Moisture ( $P < 0.05$ ) and CP ( $P < 0.0028$ ) decreased, but lipid ( $P < 0.0001$ ) increased with body condition. Generally, all age groups of camels provide meat with comparable moisture and CP contents, but higher ash, lower lipid, and fat proportion were found in camels aged 6-10 years. Camels in poor and medium body conditions provide meat with higher moisture, CP, and muscle than good condition camels. Thus, camels aged 6-10 years at medium body condition could provide better nutritive value with less health risk associated with fat. To meet the essential demands of meat consumers and the future export market, the abattoir should design and adopt the basic requirements of humane and halal slaughter.

## **Age and Body Condition Effects on Meat Quality of Camels (*Camelus dromedarius*) in Eastern Ethiopia**

*Ali Seid, Mohammed Yusuf Kurtu, and Mengistu Urge. 2018. Ph.D. Thesis,  
Haramaya University, Dire Dawa, Ethiopia*

Meat quality traits of the *M. longissimus thoracis* of 54 male Issa-Somali dromedary camels in three age groups of 6-10 years (n = 18), 11-17 years (n = 18), and  $\geq 18$  years (n = 18), with six camels in each of three body-condition-score groups (poor, medium and good) within each age group were investigated in eastern Ethiopia. Results showed that tenderness and juiciness decreased with age, but increased with body condition ( $P < 0.0001$ ). Ultimate pH was higher for muscle from the 6- to 10-year-old group (5.62) ( $P < 0.001$ ), and for the poor body-condition group (5.63) ( $P < 0.0001$ ). Meat from camels aged 6-10 years old had higher expressed juice (21.21 cm<sup>2</sup>/g vs 16.67 cm<sup>2</sup>/g) and cooking loss (42.81% vs 39.86%) than camels aged  $\geq 18$  years old. Similarly, meat from camels with poor body condition had higher expressed juice (21.42 cm<sup>2</sup>/g vs 16.39 cm<sup>2</sup>/g) and cooking loss (43.99% vs 38.48%) than that from camels with good body condition. The overall L\*, a\* , and b\* instrumental colour values were 29.66, 12.17, and 9.69, respectively. It can be concluded that camels aged 11-17 years old with medium body condition can meet the required levels for many quality traits.

## **Growth Pattern of the One Humped Camel (*Camelus dromedarius*)**

*Yesihak Yusuf and BekeleTafese 2004. In: Proc. of 11<sup>th</sup> annual conf. Ethiopian Society of Animal  
Production (ESAP), 28-30 August 2003. Addis Ababa, Ethiopia. pp. 157-166*

This paper is targeted to bring about targeted information and data available on camel growth together based on the literature citation. Herd growth of camel varies from 0.3% to 18.6% as reported to different parts of the world. In the eastern part of Africa that is in Kenya, Somalia, and Ethiopia the reported herd growth of camels was 2.8, 18.6, 9.4 and 10.66%, respectively. Camel is believed to have a very slow growth rate when compared with other domestic life stock. The growth rate up to 12 months of age depends mainly on good maternal milk supply and the absence of recognizable diseases. There is more growth (daily weight gain) from 1-12 months followed by age between 1 and 3, than 3-4. A slow down A slowdown in growth is seen at about 4-5 years of age which is a normal occurrence to all livestock as they approach mature size. Under traditional system maturity weight is attained at late age between 8 and 18. From this time onward, a drop in weight gain is observed. Faster growth for male calves up to 12 months of age is attained than the female of the same age. From one to four years of age, immature females gain weight faster than that of the male of the same age. Other husbandry management like nutrition and health also plays significantly in daily weight gain.

## **Production Systems and Reproductive Performances of *Camelus dromedarius* in Somali Regional State, Eastern Ethiopia**

*Simenew Keskes, Mohamed Ibrahim, Tesfaye Sisay, Berhan Tamir, Fekadu Regassa, Tesfu Kassa, Fufa Dawo. 2013. Journal of Agriculture and Environment for International Development (JAEID), 2013, 107  
(2): 243 - 266.*

Across-sectional questionnaire surveys and focused group discussions were conducted to characterize camel production systems and to evaluate reproductive performances of camels at their natural pastoralist management systems of the Somali region. A total of 100 households were included in the study during the period of October 2012 to March 2013. About 98% of

Somali pastoralists preferred camels as their first choice over other livestock species and mainly kept in the society for milk and meat production. The camel management dominating in the study areas of the Somali region is traditionally nomadic. Camel is one of the most important livestock for Somali pastoralists' livelihood as a source of milk, meat and draught power. Mature female camels were dominant (54.87%) in the camel herd. The ratio of male to female camel was 1:13. Mean age at first calving and calving interval were  $62.16 \pm 10.44$  and  $23.28 \pm 3.36$  months respectively. Age at first calving and calving interval can be minimized to  $57 \pm 5.52$  and  $21.84 \pm 4.8$  months by proper husbandry and health care. The mean lactation length was  $11.51 \pm 1.91$  months. Diseases and predators were reported as the main causes of calf mortality. The calf mortality rate among Somali camels can be reduced at least to 7% only by preventing predators attack and if other disease preventions and management cares are in place it can be reduced to the maximum. Diseases (66%), lack of pasture (59%), and security (47%) were the main constraints in the camel production of the study areas. For the better productivity of camels, the major constraints such as disease problems, lack of pasture, and tribal conflicts should be mitigated. Proper husbandry and health services can play significant roles in the long term improvement of camel production and productivity of the region.

### **Characterization of Camel Production System in Afar Pastoralists, Northeast Ethiopia**

*Simenew, K., Dejen, T., Tesfaye, S., Fekadu, R., Tesfu, K. and Fufa, D. 2013. Asian Journal of Agricultural Sciences 5(2): 16-24.*

A cross-sectional questionnaire survey was conducted to characterize the camel production system in Afar Region. From the 110 responses of the camel, owners interviewed 68.2% of them prefer camels as their first choice over other livestock species and mainly kept in the society for milk production. Disease accounted for 40.9% of the main problems of the camel rearing society of the Afar pastoralist and about 35.8% of the camel culling reasons were attributed to camel diseases. External parasite infestation and pneumonia were the most common health problems with 51% and 31.8% respectively. More than 80% of breeding male camels were selected from the own herd and rarely acquired from other sources. The (Mean $\pm$ S.D.) age at first calving was  $5.36 \pm 0.74$  years in afar female camels and the life span ranges from 14-29 years. Daily milk yield of Afar camels ranges from 2.01-12.0 liters per day in 2-3 milking times. The average age to select breeding male is  $2.75 \pm 1.50$  years. Policymakers, researchers, and funding agencies should give attention to camels in combating food security in the ever-widening desertification in areas like Afar.



# Part II

# Dairy



Photo credit: Sisav Tilahun





## **Analysis of Camel Milk Value Chain In The Pastoral Areas of Eastern Ethiopia**

*Takele Wolkaro, Mohamed Yusuf Kurtu, Mitiku Eshetu, Mengistu Ketema  
Journal of Camelid Science 2017, 10: 1–16 <http://www.isocard.net/en/journal>*

This study was conducted to analyze the camel milk value chain with the aim of characterizing the chain actors and their roles, pinpoint value chain constraints and opportunities and finally suggest interventions required for improving the performance of the camel milk subsector in the pastoral areas of eastern Ethiopia. A total of three hundred fifteen key informants were interviewed using a structured questionnaire. Moreover, concerned organizations and institutions were accessed and available relevant documents have been searched to gather supplementary secondary information. The value chain analysis revealed that the major value chain actors are input suppliers, pastoral producers, rural and urban assemblers, wholesalers, milk market cooperative, private processors, retailers, and consumers. In spite of the existence of substantial potential, the camel milk subsector does not make a considerable contribution to the livelihood of the pastoral communities due to production and marketing constraints. Furthermore, inefficient marketing systems coupled with poor linkages among the concerned stakeholders conspire to limit the growth of the subsector. Meanwhile, high demand and expanding exports directly to the relatively wealthy Middle East markets are major opportunities. It is, therefore, very important that all the constraints identified in this study need to be carefully considered and addressed. The study further suggests that coordination and intervention strategies should be designed and applied across the entire value chain in order to develop the subsector.

## **The Ethiopian Dairy Value Chain with a Particular Focus on Cattle and Camel Milk: Current Scenarios and Investment Opportunities**

*Zelalem Yilma, Yonas Hailu, Takele Wolkaro, Mitiku Eshetu 2017. East African Journal of Sciences (EAJS) Volume 11 No.2. 2017*

Cattle and camel represent important cultural, social, nutritional as well as economic values to a substantial proportion of the livestock keeping communities dwelling in various agro-ecologies of Ethiopia. The country has a substantial potential for dairy development considering the large livestock populations found in the country with other productivity-enhancing factors. However, despite the large population, the productivity is by far low; that the country to be a net importer of dairy products with import values significantly exceeding export values. Among others; limited market outlets for milk and milk products, inefficient and untimely artificial insemination service delivery, lack of crossbreed heifers, shortage and increasing price of feeds especially agro-industrial by-products and poor linkages among key value-chain actors are the frequently cited factors deemed guilty. It is, therefore, with this breathing situation that this review report made an effort to highlight the prevailing situation of the Ethiopian cattle and camel milk value chains as well as the missing link. Based on the current scenario, it also suggests appropriate improvement interventions to take and when taken right then producers in particular and the country, in general, could make use of optimum if not maximum benefits that can be tapped from the sector.

## **Metagenomic Analysis of Bacterial Community Composition in Dhanaan: Ethiopian Traditional Fermented Camel Milk**

*Tesfemariam Berhe, Richard Ipsen, Eyassu Seifu, Mohamed Y. Kurtu, Angelina Fugl, and Egon Bech Hansen*  
*FEMS Microbiology Letters, Volume 366, ISSUE 11, June 2019*

This study was conducted to evaluate the safety and bacterial profile of *Dhanaan* (Ethiopian traditional fermented camel milk). The composition of the microbial community in *Dhanaan* samples was analyzed by a metagenomic approach of 16SrRNA gene amplicon sequencing. Metagenomic profiling identified 87 different bacterial microorganisms (OTUs) in six samples analyzed. Although the *Dhanaan* samples contained various lactic acid bacteria (LAB) they also all contained undesirable microorganisms in large proportions. The following LAB genera were identified: *Streptococcus*, *Lactococcus*, and *Weissella*. One *Streptococcus* species represented by OTU-1 (operational taxonomic unit) was found in all *Dhanaan* samples and the dominating species in four out of six samples. This common isolate was found to be closely related to *S. lutetiensis* and *S. infantarius*. Undesirable microorganisms from genera such as *Escherichia*, *Klebsiella*, *Enterobacter*, *Acinetobacter*, and *Clostridium* were, however, also frequent, or even dominant in *Dhanaan* samples. Thus, this calls for a change in the *Dhanaan* manufacturing practice to an improved and safer production system. Starter cultures suitable for *Dhanaan* production might be developed from the *Streptococcus*, *Weissella*, and *Lactococcus* microorganisms identified in this study. However, further safety evaluation and technological characterization need to be conducted on strains defined by OTU-1, OTU-2, OTU-3, OTU-8, and OTU-35 before they can be used as food-grade starter cultures.

## **Physicochemical Properties of Butter Made from Camel Milk**

*Tesfemariam Berhe, Eyassu Seifu, and Mohamed Y. Kurtu*  
*International Dairy Journal 31(2013) 51-54*

The making of butter from camel milk using a traditional churning method and the physicochemical properties of the butter were assessed. Camel milk was obtained from pastorally managed camels in Erer valley, eastern Ethiopia. Churning time, butter yield and fat recovery efficiency of camel milk were 120 min, 43 g L<sup>-1</sup> and 79.8%. Camel milk butter had average values of 64.1 ± 5.2%, 55.8 ± 1.6%, 6.7 ± 2.5 mg KOH g<sup>-1</sup>, 4.90 ± 0.15, 43.2 ± 0.8°C and 1.4530 ± 0.0002 for total solids, fat, acid degree value, pH, melting point and refractive index, respectively. The results showed the possibility of making butter from camel milk; however, further research is needed in order to reduce churning time and improve butter yield.

## **Processing Challenges and Opportunities of Camel Dairy Products**

*Tesfemariam Berhe, Eyassu Seifu, Richard Ipsen, Mohamed Y. Kurtu, and Egon Bech Hansen*  
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A review of the challenges and opportunities of processing camel milk into dairy products is provided with the objective of exploring the challenges of processing and assessing the opportunities for developing functional products from camel milk. The gross composition of camel milk is similar to bovine milk. Nonetheless, the relative composition, distribution, and the molecular structure of the milk components are reported to be different. Consequently, manufacturing of camel dairy products such as cheese, yogurt, or butter using the same



technology as for dairy products from bovine milk can result in processing difficulties and products of inferior quality. However, scientific evidence points to the possibility of transforming camel milk into products by optimization of the processing parameters. Additionally, camel milk has traditionally been used for its medicinal values and recent scientific studies confirm that it is a rich source of bioactive, antimicrobial, and antioxidant substances. The current literature concerning product design and functional potential of camel milk is fragmented in terms of time, place, and depth of the research. Therefore, it is essential to understand the fundamental features of camel milk and initiate detailed multidisciplinary research to fully explore and utilize its functional and technological properties.

## **Comparison of the Acidification Activities of Commercial Starter Cultures in Camel and Bovine Milk**

*Tesfemariam Berhe, Richard Ipsen, Eyassu Seifu, Mohammed Y. Kurtu, MitikuEshetu, Egon Bech Hansen  
Food Science and Technology 89 (2018) 123–127127: journal homepage: [www.elsevier.com/locate/lwt](http://www.elsevier.com/locate/lwt)*

Camel milk has been reported to be difficult to ferment due to anti-microbial properties. The present study tested eight commercial starter cultures for their ability to grow in camel milk. All investigated cultures were able to acidify camel milk and reached a final pH at a level similar to what was achieved in bovine milk, but the speed of acidification was generally lower in camel milk. This could be due to inhibitory substances in camel milk or due to reduced availability of nutrients. Experiments using mixtures of camel and bovine milk or supplementation with casein hydrolysates allowed us to distinguish between these possibilities. High acidification rates were obtained in camel milk mixed with bovine milk or supplemented with casein hydrolysate. This demonstrates that the cultures are not inhibited by camel milk and we conclude that the growth rates of these cultures in pure camel milk are limited by the rate of proteolysis.

## **The Dromedary Camel Supplementation for Higher Milk yields and Behavior and Feed Preference on the range in Eastern Ethiopia**

*Moges Derege Arega. 2001. M. Sc. Thesis,  
Haramaya University, Dire Dawa, Ethiopia*

Two studies were carried out in the semi-arid part of Eastern Ethiopia in Error valley to study the effect of energy supplement (ES), protein supplement (PS) and no (control) supplementation on milk yield and milk composition and the behavior, plant preference and quality of forage of herded dromedary camels. Maize (*Zea mays*) grain and decorticated groundnut (*Arachis hypogaea*) cake (4kg/d) were used and energy and protein supplements in the first experiment. Yield varied between treatments and seasons. Treatment effects were highly significant ( $P < 0.001$ ) and ( $P < 0.5$ ) with PS ( $12.9 \pm 0.27$ ) > ES ( $9.1 \pm 0.21$ ) > control ( $7.6 \pm 0.24$ ) kg and with PS ( $3.9 \pm 0.03$ ) > Control ( $3.74 \pm 0.06$ ) > ES ( $3.72 \pm 0.04$ ) percent for milk yield and butterfat, respectively. In spite of the more advance stage of lactation milk yield and butterfat were significantly ( $P < 0.05$ ) higher in the wet season (10.4-kg milk and 3.8% butterfat) as compared to the dry season (9.2kg milk and 3.7% butterfat) In experiment II camel behavior and dietary preference on the range was studied combined with forage analytical studies. Browsing was the major activity for all the categories and both seasons occupying 59-69% of the total day time activities. Least time was devoted to ruminating by all the categories in both seasons. In general, the young camels spent more time browsing and less time on resting and other activities as compared to the adult camels. Seasonal variation indicated that more time was spent on walking and browsing and less time on ruminating in the dry season as compared to the wet. The dietary preference study indicated that 21 plant species in the dry and 30 in the wet season were

consumed. Woody perennials occupied approximately 79 and 83% of the total feeding time in the dry and the wet seasons, respectively. Similarly, the top ten preferred plants accounted for 87 and 80% of total feeding time respectively. The most preferred plants were *Opuntia* dry season and *Acacia brevispica* in the wet season occupying 18 and 22% of total feeding time respectively. Plant composition ranged for crude protein from 8.8 to 22.8%, for P 0.13 to 0.33%, for Ca 1.2 to 4.8%, for *in vitro* dry matter digestibility 40.8 to 65.4%, for soluble tannins 2.9 to 21.6% and for condensed tannins 9.4 to 129.0 abs, unites/g. The analytical results combined with time spent on individual plants showed that the camels obtained a diet of approximately 17% crude protein from the range in both seasons.

### **Milk Production of Dankali Camels in Ethiopia**

*Rechard, D. and Gerard D. 1989. Revue Elev. Med. Vet. Pays Trop. 1989. 42 (1): 97-103*

Over a three and a half year period, monitoring of five Dankali female camels kept on natural pasture enables six full lactations, six inter-birth intervals, eleven births and the growth of five calves to be followed. In addition ninety- nine milk controls were performed. The milk mean represents 1123 liters per head over 2.25 months. The persistence rate is high: 97.1 and 74.1 p. 100 over the hundred days, respectively. The lactation peak is reached at day 56.5 with a 4.4-liter volume. The inter-birth period is highly variable, ranging from 13 to 32 months with a mean of 22 months. The interval between a given birth and the next fertile servicing may be short and lactation may continue up to an advanced stage of pregnancy. The observed production is compared with total recordings gathered in the same area and over similar types of animals but kept under different management and feeding conditions.

### **Traditional Medicinal Value of Camel Milk in Babilie and Kebribeyah Woredas of the Jigjiga Zone, Somali Region, Ethiopia**

*Yohannes Mehari, Zeleke Mekuriaw, and Getachew Gebru. 2007 J. of Livestock Research for Rural Development (LRRD) 19 (4)*

The study was conducted between July 2005 and January 2006 in Babilie and Kebribeyah woredas, Jigjiga Zone of the Somali Regional State with the objective of identifying the traditional medicinal value of camel milk, meat and urine in the study areas. The method of data collection employed was a single visit formal survey. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 12. The existence of a wealth of indigenous knowledge for treating human and animal diseases was identified in this study. Almost all respondents from Babilie and Kebribeyah recognize the medicinal value of camel milk but the therapeutic value of camel meat and urine is only known by some of the respondents of the same woredas. For corresponding human and animal diseases there are traditional ways of treatment using camel milk, meat, and urine and for some diseases (human and animal) even dosages were indicated.

### **Traditional Cow and Camel Milk Production and Marketing in Agro-Pastoral and mixed Crop– Livestock Systems: The case of Mieso District Oromia Regional State, Ethiopia**

*Kedija Hussen, Azage Tegegne, Mohammed Yousuf Kurtu and Berhanu Gebremedhin. 2008 ILRI Publications Unit, Addis Ababa, Ethiopia. Working Paper No. 13*

The study was conducted in Mieso district of Oromia Regional State, located 300 km east of Addis Ababa and at about 200 km east of Adama. The objectives of the study were to

characterize the traditional milk production and marketing system, as well as identify constraints and opportunities for further development. Five rural kebeles, Dire Kalu, Gena, Huse Mander, Hunde Misoma, and Welda Jebeba that have milk production potential were selected using purposive sampling. Farmers/agro-pastoralists from each rural kebele were selected using Proportional Probability to Size (PPS) approach and a total of 120 farmers/agro-pastoralists were selected using a systematic random sampling method. Group discussion was conducted with key informants such as elders and experts in the Office of Pastoral and Rural Development to have an overview of the overall milk production and marketing system. The information generated in participatory rural appraisal phases was used for the preparation and development of a questionnaire for the formal survey. The questionnaire was pre-tested and modified as necessary. The formal survey was conducted by trained enumerators in 2005/06 using 120 farmers. To capture gender effects in the overall production system, the sample household on each rural kebele was stratified into female- and male-headed households. For the market study, from the three existing market sites, Mieso and Asebot markets were purposively selected. Milk marketing was monitored during the rainy and dry seasons. A questionnaire was used to collect information on the amount of milk delivered, price, and the number of individuals who sell milk. During the monitoring phase, a diagnostic survey was undertaken to identify households that have lactating cows and/or camels in the selected five rural kebeles. Lactating cows were stratified into early (1–2 months), mid (3–4 months), and late (5–6 months) lactation stages while camels were stratified into early (1–3 months), mid (4–6 months) and late (7–9 months) lactation stage, depending on their lactation length to see the production potential at different stages. About 10% of the total lactating cows and camels in each lactation stage from each rural kebele were used. Daily cow milk yield (morning and evening) was measured using a calibrated plastic jug for a period of one week. For camels, daily milk yield was measured three times a day (morning, mid-day, and evening). Cattle, camels, and goats are used for milk production in the district. All milk animals in the study area are indigenous breeds. All the respondents indicated that cattle, camel, and goats are principally fed on natural pasture on non-arable lands maintained under rainfed conditions. Crop residues, mainly sorghum and maize thinning (locally known as chinki), sorghum, and maize stover (locally known as Kera), and household waste all serve as important feed resources for livestock. As an additional feed, mineral soil salt (locally known as haya) is used by about 40% of the respondents during the wet and dry seasons. Average cow milk yield/head per day in the wet and the dry season was estimated at  $3.26 \pm 0.07$  liters and  $1.63 \pm 0.04$  liters, respectively. Similarly, camel milk yield/head per day in the wet and dry season was  $7.12 \pm 0.33$  liters and  $3.85 \pm 0.203$  liters, respectively. The estimated average cow milk produced per household per day during the wet and the dry season was  $4.80 \pm 0.22$  liters and  $2.37 \pm 0.11$  liters, respectively. Similarly, the estimated average camel milk produced per household per day was higher during the wet ( $13.19 \pm 0.95$  liters) than the dry season ( $7.63 \pm 0.82$  liters). Milk and milk product sales (96%) and crop sale (95%) are the major sources of income for the farmers/agro-pastoralists, indicating that both commodities are equally important. The majority of the households sell whole milk (78%) and butter (67%). Only 4.2% of the respondents sell whey. About 72% of the respondents indicated that cow milk is sold both during the wet and dry seasons. Some 8.3% of the respondents sell milk only during the wet season. Twenty-nine percent of the households indicated that only one-fourth of the total household milk production is delivered to the market, and mostly the morning milk is sold while the evening milk is often used for home consumption. During the dry season, the amount of cow and camel milk supplied to the market decreases by 39 and 28%, respectively. The amount of cow and camel milk sold per day was significantly ( $P \leq 0.05$ ) higher in Mieso ( $496.6 \pm 19.12$  liters) than in the Asebot market ( $187.89 \pm 19.12$  liters). Milk sold per day during the wet season was significantly ( $P \leq 0.05$ ) higher than during the dry season for both cow and camel milk. There were generally two types of milk outlets identified in the district. These are traditional

milk associations or groups and individual sellers. The traditional milk producer association group is locally called Faraqa Annanni. From a total of 94 households that sold milk during the study, only 22 households (23%) were involved in the milk seller groups. The average amount of milk contributed by an individual in group marketing was significantly ( $P \leq 0.05$ ) higher ( $3.94 \pm 0.17$  liters/person) than individual sales ( $1.64 \pm 0.06$  liters/person). The total amount of milk sold (liter/person per day) at the two market sites differed significantly, being higher in Mieso ( $3.27 \pm 0.17$  liters/person) than in Asebot ( $1.91 \pm 0.06$  liters/person) market. The distance of the household from the market was an important variable that significantly ( $P \leq 0.05$ ) affected the decision on cow milk marketing. The availability of Faraqa Annanni in the area also had a significantly ( $P \leq 0.1$ ) positive relationship with participation in cow milk marketing. The availability of Faraqa Annanni in the vicinity increased the opportunity of the household to market cow milk by 14%. Most of the respondents indicated that milk sale was highly affected by low milk quantity (73%) followed by distance to market (38%). The cultural taboo on milk marketing was limited and was identified by only 7.6% of the respondents, indicating that this issue is not a serious problem in the area. Feed scarcity, water shortage, security problems, and limited access to veterinary services were identified as the major problems to dairy production by 41, 30, 14.5, and 8% of the respondents, respectively. Mortality due to diseases was identified as a major cause of loss in cattle (65% of respondents) and camels (67% of respondents). In conclusion, this study has shown that there is good potential for market-oriented dairy development in the woreda. However, there is a need for intervention to develop infrastructure, enhance the input supply system, and undertake capacity development and training to enhance the skills of farmers and pastoralists in dairy production, processing, and marketing. Attention should also be given to effective conflict management and resolution including the application of customary systems, improved access to veterinary services including training of paravets, improved feed production, and conservation systems, feeding strategies and systems, improved milk handling, processing, and marketing system and introduction of improved dairy breeds in some areas where feasible.

## **The Potential of Camel Milk and Extracts of Major Plants Browsed by the Animal for Diabetes Treatment**

*Negussie Bussa, Anteneh Belayneh, Merga Deressa 2017.  
East African Journal of Sciences (EAJS) Volume 11 No.2. 2017*

Diabetes is one of the world's greatest healthcare challenges affecting millions of people, and recognized as one of the emergings, and challenging public health problems in Ethiopia. This study was done to evaluate the potential of camel milk and extracts of major plants browsed by the animal for the treatment of diabetes. Fresh samples of both camel milk and major plant species frequently browsed by camels were collected from Babile (Oromia Region) and Shinille (Somali region). Taxonomic identification of the plant species browsed by the animal was made, the leaves were dried under shade, and pulverized for nutrient analysis and extraction. Crude extracts were kept under low temperature ( $4^{\circ}\text{C}$ ) until fed to experimental rats. Eighty adult Wistar rats were divided into sixteen groups and groups one through twelve were injected Streptozotocin (STZ) for diabetic whereas groups thirteen through sixteen kept non-diabetic. Group one through six were fed on the plant extracts. Groups seven through sixteen were diabetic and non-diabetic male and female treated with camel milk, Glibenclamide ( $500 \mu\text{g}/\text{kg}$ , p.o.), and aqueous solutions. Blood glucose levels of the rats were measured before STZ, 72 hours after STZ, and every week until the end of the experiment. Camel milk feeding showed a glucose level reduction by 20.5% in the male rate and 21.1% in the female rate. There is no significant difference in glucose level reduction between males and females ( $p > 0.05$ ). Extracts from *Acacia brevispica* and *Dichrostachys cinerea* showed 28.1% and 21% of glucose level

reductions, respectively in diabetic rats. *Balanites aegyptiaca* showed 55.4% of glucose level reduction, a significant change ( $p>0.05$ ). This preliminary finding indicated that using camel milk in the diet could alleviate diabetes, which is encouraging for further research work with more parameters and better laboratory facilities.

## **Clotting Activities of Partially Purified Extracts of *Moringa oleifera* on Dromedary Camel Milk**

*Mezgebu Abate Terefe, Ameha Kebede, Misrak Kebede, 2017 East African Journal of Sciences (EAJS) Volume 11 No.2. 2017*

Processing camel milk into shelf-stable value-added milk products is not yet well developed. Unlike the milk of cows and small ruminants, camel milk does not readily coagulate by rennet due to its inherent properties. Therefore, experiments were conducted to evaluate the clotting activities of partially purified *Moringa oleifera* extract on camel milk and to identify the optimum pH, temperature, and concentration of the partially purified extract that would result in strong curd of camel milk. These included three temperature points (55, 60 and 65°C), three pH values (4.5, 5 and 5.5) and five levels of partially purified *Moringa oleifera* extracts obtained from seed and leaf samples (0, 10, 20, 30 and 40%). The results revealed that temperature, pH, and concentrations of partially purified seed and leaf extracts of *Moringa oleifera* had a significant ( $p<0.05$ ) effect on the clotting activities of camel milk. The highest camel milk clotting activity and curd firmness were observed at pH 5, the temperature of 65°C and partially purified extract concentration of 10% for both seeds and leaves, while the lowest values were recorded at pH 5.5, the temperature of 55°C and a partially purified extract concentration of 40%, respectively. An increase in camel milk clotting activity was observed with a decrease in milk pH from 5.5 to 4.5. Camel milk clotting activities increased with increasing temperature. However, it decreased with an increase in partially purified extract concentration for both seed and leaf extracts. Therefore, the capability of the partially purified extract of *Moringa oleifera* seeds to coagulate camel milk and to form firm curd combined with its high ratio of milk clotting to proteolytic activity could make it a useful rennet substitute in the dairy industry.

## **Opportunities for Producing Dairy Products from Camel Milk: A Comparison with Bovine Milk**

*Richard Ipsen. East African Journal of Sciences (EAJS) Volume 11 No.2. 2017*

Camel milk is known to differ markedly from bovine milk in terms of its detailed protein composition and colloidal structure. Noteworthy is the lack of B-lactoglobulin, the small content of k-casein, and the high proportion of  $\beta$ -casein in the casein micelles of the milk. The colloidal structure is also different from larger casein micelles and smaller fat globules. The present review presents and discusses current knowledge on the composition and colloidal structure of camel milk, relates this to bovine milk, and points out where research is lacking and what opportunities for processing of camel milk appear to be most promising. Pasteurized camel milk appears straightforward and is used industrially, but UHT and sterilization treatment of camel milk cause protein instability. Hence, research is needed to solve this problem. Acidified milk drinks appear promising as do the production of camel milk cheese. Butter and ghee production is possible and camel milk can be made into palatable ice cream. The different colloidal structure of camel milk, compared to bovine milk, means that most processing technology cannot be directly transferred and there is hence a need for suitable research-based adaptations. Camel milk is known to differ markedly from bovine milk in terms of its detailed protein composition and colloidal structure.

## **Coagulation and Preparation of Soft Unripened Cheese from Camel Milk using Camel Chymosin**

*Tekuam Walle, Mohammed Yusuf, Richard Ipsen, Yonas Hailu, Mitiku Eshetu 2017. East African Journal of Sciences (EAJS) Volume 11 No.2. 2017*

Camel milk is known for not being suitable for processing it into different dairy products. Efforts have been made to make cheese from camel milk, but still, there is no well-accepted manufacturing protocol to be adopted. Hence this experiment was initiated to investigate the effect of different levels of camel chymosin concentrations on camel milk gelation properties and the influence of cooking (at 55°C) on the characteristics of soft unripened cheese made from camel milk. Soft unripened cheese was made with 3x2 factorial design with CRD arrangement in which three levels of camel chymosin concentrations (40, 70, and 100 IMCU/L) and two levels of cooking (cooked and uncooked curd) and then cheese quality, yield, texture profile analysis (TPA) hardness and sensory attributes were analyzed. The shortest gelation time was observed for camel chymosin concentration of 100 IMCU/L and 70 IMCU/L whereas the highest maximum gel firmness was observed for camel chymosin level of 40 IMCU/L. Significantly highest ( $P < 0.001$ ) cheese yield was observed for uncooked cheese at 100 IMCU/L coagulant level. Cooked cheese made using 100 IMCU/L had significantly highest values for protein, total solids, ash, and hardness. Whereas, the color of the texture and the appearance scores were significantly higher for 40 IMCU/L cooked cheese. However, the taste, aroma, and overall acceptance of cooked cheese made using 70 IMCU/L gave the highest score. It could be concluded that using medium level chymosin concentration (70 IMCU/L) as well as cooking of camel milk curd could be suitable approaches for making soft unripened cheese from camel milk.

## **Traditional Processing of Camel Meat and Milk, and Marketing of Camels, Milk, and Hides in Afder Zone of Somali National Regional State, Ethiopia**

*Ahmed Sh-Mohamed, Hegde B. P. and Bekele Tafesse. 2003. In: Proc. of 10<sup>th</sup> annual conf. Ethiopian Society of Animal Production (ESAP), 21-23 August 2004. Addis Ababa, Ethiopia. pp. 201-210*

This study was initiated with the objectives of generating baseline data in the area of traditional meat and milk processing, marketing of camel, and its products. The study was undertaken in the five purposively selected Weredas of Afder Zone. Sampling methods used were stratified random sampling technique wherein each Woreda five small (10-20 camels) medium (21-50 camels) and large (<50 camels) herders were considered. 'Olobe' and 'Darreein' are the two types of traditionally processed meat in Afder. These products are prepared to extend the use of meat for a longer time especially for the dry season and for cultural reasons. Of the two types 'Olobe' is available in the urban market. These products are also prepared during crises when large numbers of animals are dying. 85, 69, and 52 percent of the small, medium, and large herd size camel owners respectively reported their preference for freshly cooked meat. Smoking of camel milk containers is practiced to improve the taste and the quality of milk. Souring of milk is practiced at any time when surplus milk is available. The mean maximum shelf life of soured milk under pastoral practice is 6.1, 5.8, and 6.7 days respectively as opined by small, medium, and large herd size camel owners respectively. Livestock marketing infrastructure is not well organized in Afder. The major market outlet is Kenya and Somali and locally Doll-ado, Hargelle, and Jerati. The mean numbers of camels sold were 2.1, 2.5, and 3.5 for small, medium, and large herd sizes, respectively. Mostly adult males and females were brought to the

Jerati market. The price of a camel in the Jerati market varies from 370 Birr for an immature camel to 1350 Birr for an adult camel. Milk marketing is limited to certain towns due to a lack of transportation facilities. The price of milk varies from 0.50 to 8.10 Birr in different districts. Distance, season, and quality of milk are the factors that affect the milk price. Pastoralists sell or purchase camel hides by cash or in kind. The large herd owners get more hides to sell compared to small herd owners. The price of hides varies from 40 Birr to 240 Birr in the study area.

## **Milk Production, Persistency, and Composition of Pastorally Managed Camels in Eastern Ethiopia**

*Kebebew Tuffa. 1998. M. Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

Thirty lactations of camels belonging to one herd having 100 animals were monitored during 19 months from March 1996 to September 1997 in the Error Valley, eastern Ethiopia to examine the milk production and persistency characteristics of camels under natural environments. The effect of season of calving, parity groups, and calf death on milk production traits (lactation length, daily, peak, monthly and total lactation milk yield, persistency, and day's open and calving interval) were analyzed the General Linear Model (GLM) procedure. Lactation curves were drawn for different calving season and parity groups of camel cows. The least-square means of the daily, peak, lactation yield and lactation length were 7.5, 11.15, 2104 liters respectively. The average lactation monthly milk yield was 229 liters. The lactation length was 282 days. The persistency indices, calculated were 120 and 89% for P1 and P2, respectively. The least-square means for days open and calving intervals were 199 and 573 days. All parameters were significantly affected by the season of Calving except persistency expressed in P1 and monthly milk yield. The maximum daily and lactation yields were observed during the 3<sup>rd</sup> and 4<sup>th</sup> lactations. Camels whose calves died had a significantly higher yield than camels whose calves surviving to wean. The lactation curve had a typical shape, although less pronounced for camels that calved during the long dry season. Camels that calved in the long wet season and old camels showed the lowest persistency. For milk composition studies, milk samples from 41 camel cows of different age, stage of lactation numbers during the wet and dry season were analyzed for fat, protein, casein, TS, and SNF, respectively. The least-square means were 3.9, 2.9, 2.3, 13, and 9%, for fat, protein, casein, TS, and SNF, respectively. The effect of season was highly significant for fat SNF, but not for the other components. During the dry season, milk fat percentage was lower than the fat percentage of the wet season milk. The fat content also varied with parity and stage of lactation. The protein and casein were not significantly affected by all factors considered. TS was significantly affected by lactation number.

## **Characterization of Camel Husbandry Practice and Milk and Meat Utilization in Jigjiga and Shinile zones, Somali Region, Eastern Ethiopia**

*Tezera Getahun. 1998. M. Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

Camel husbandry and camel milk and meat utilization were studied in Jigjiga and Shinile zones of Somali Region in 1996. The main objectives were to describe the camel husbandry practices and camel milk and meat utilization in the study area. Eighty-four households were interviewed in from these zones using questionnaires. In addition, records on body measurements of 226 camels of different sex and age groups were taken. Herd demography, information on reproductive performance, her management, and feeding and watering, disease and health problems, livestock holdings, milk, and meat production, as well as consumption and processing

and marketing, were collected. The calves, immature and adult camels in family herds were on an average accounted for 17%, 21.1% and 61.2% in Jigjiga (n = 53, 1867 heads); and 15.7%, 26.1% and 58.2% in Shinile (n=31, 704 heads). The percentage of total females in herd and females of breeding age (out of total females) was 75.4%, 68.7%, and 74.8%, and 66% in Jigjiga and Shinile, respectively. Two traditional camel types were identified namely the Agoweiyin and the Ayuune. The chest girth and Estimated body weight for female and male Agoweiyin and Ayuune type were 1.96 m  $\pm$  0.10, 427 kg  $\pm$  62.18 (n=31), and 2.04 m  $\pm$  0.14, 486  $\pm$  81.25 (n=55); and 1.59 m  $\pm$  0.11, 326 kg  $\pm$  62.91 (n=31), and 1.93 m  $\pm$  0.11, 384 kg  $\pm$  80.76 (n=18), respectively. The percentage of interviewed householders who had at least breeding bull, fit age at first mating and bred camels in the wet season was 83%, 61.2%, and 69.8% in Jigjiga; and 83.9%, 67.7%, and 61.3% in Shinile, respectively. Age at first mating, the productive life span for females and males in years, and potential offspring per dam lifetime were 4.7, 6.2, 23.1, 9.3, and 11.6 in Jigjiga, and 4.4, 6.5, and 22.4, 9.7, and 11.6 in Shinile respectively. The calculated fertility rate in the mixed herd was 3.91 (n=106) and 3.47 (n=60) in Jigjiga and Shinile, respectively. Out of all calves born alive, 67.6% (n=414) and 76.4% (n=208) were in the herd in Jigjiga and Shinile during the survey, respectively. The percentage of offspring left in the herd due to death was 69.4% (n=134) and 53.1% (n=49) of which death due to disease and predators accounted for 68.8% and 29%; and 61.5% and 34.6% in Jigjiga and Shinile, respectively. Abortion and stillbirth rates were 8.1% and 4.2% in Jigjiga and 11.1% and 4.2% in Shinile. Calves 'mortality (less than two years) was accounted for 48% (n=93) and 34.6% (n=26) of total death in Jigjiga and Shinile, respectively. The major camel production constraints were a disease, feed shortage, and predators. The average family size, camel herd size, TLU per household, and TLU per capita were 10.6, 35.2, 50.1, and 5.2, in Jigjiga, and 9.8, 22.7, 40.5, and 4.3 in Shinile. The percentages of polygamous households were 43.3% and 22.6% in Jigjiga and Shinile, respectively. The households having camels plus three other livestock species were 47.2% and 4.9% in Jigjiga and Shinile, respectively. The mean of lactating camels per herd, lactation offtake and lactation length was 16.6%, 2009 kg (range 1050-3150 kg), 15 months (range 12-18) in Jigjiga; and 11.6%, 1244 kg (range 600-2000 kg) and 13 months (range 12-17) in Shinile, respectively. The percent of household who consumed all the camel milk they produced during the wet and dry season was 24.5% and 39.6% in Jigjiga and 97.8% and 100% in Shinile, respectively. In the same line, the percent of household who sold at least one-third of the milk they produced during the dry season were 60.4% and 0% in Jigjiga and Shinile, respectively. No product of camel milk was identified in both zones but 58.8% of households in Jigjiga and 74.2% in Shinile practiced purposeful milk souring. The per capita camel meat consumption for both sites was 19.9 kg for the year 1996. Of the total camels slaughtered, 0.88% was due to disease and cultural ceremonies. It is concluded that the camel husbandry practices characterized by target-oriented selection and control breeding practices, better reproductive status, risk averting management strategy, high degree of livestock diversification and high milk yield, and meat production potentials for future development interventions.

## **Physiochemical Properties and Microbiological Quality of DHANAAN: Traditional Fermented Camel Milk Product in Eastern Ethiopia**

*Kasa Biratu. 2012. M. Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

This study was conducted with the objectives of assessing the production, handling and utilization practices of the traditional fermented camel milk Dhanaan produced in Jigjiga, Wordeja and determining physicochemical properties and microbiological quality of traditional and laboratory mad Dhanaan. The study had two parts: One was the survey on production,



handling, and utilization practices of Dhanaan and conducted among sixty camel milk-producing households in three selected Kebele of Jigjiga woreda. Selection of the Kebele was done based on their possession of camel and accessibility whereas selecting of households was done using a purposive sampling technique based on possession of milking camels, accessibility, and willingness to take part in the study. All Camel milk producers were interviewed individually using a semi-structured questionnaire. For collecting samples for the experiment part, nine households, three from each Kebele, were purposively selected base on milking camel possession, accessibility, and willingness to participate in the study. Fresh raw milk used to prepare Dhanaan in the laboratory was also sampled from the bulk milk container among selected households one from each Kebele. A total of 36 Dhanaan samples (27 traditionally made plus 9 laboratories made Dhanaan) were analyzed for their Physiochemical properties and microbiological quality. The survey result indicated that Dhanaan is the only camel milk product popular in the study area produced by spontaneous fermentation process to be used as food, means of conserving milk, and increasing its shelf life and treating some diseases. The overall mean (SD) values for pH, titratable acidity, total protein, fat, total solids, solid-not-fat and ash were  $4.18 \pm 0.29$ ,  $1.75 \pm 0.34\%$  lactic acid,  $4.11 \pm 0.67\%$ ,  $2.50 \pm 0.60\%$ ,  $11.08 \pm 2.47\%$ ,  $8.64 \pm 2.08\%$  and  $0.96 \pm 0.03\%$ , respectively for traditionally made Dhanaan. Whereas the corresponding values for laboratory-made Dhanaan samples were  $4.04 \pm 0.25$ ,  $1.54 \pm 0.26\%$ , lactic acid,  $4.04 \pm 0.42\%$ ,  $2.39 \pm 0.56\%$ ,  $11.83 \pm 1.24\%$ ,  $7.78 \pm 1.22\%$ , and  $0.99\%$ , respectively. No significant difference ( $P > 0.05$ ) was observed between traditional and laboratory-made Dhanaan samples for all the physicochemical parameters considered. The average (SD) total bacteria count (TBC), coliform count (CC), lactic acid bacteria count (LABC) grown on MRS agar, lactic acid bacteria count (LABC) grown on M 17 agar, non-lactic acid bacteria count (NLABC) and yeast and mold count (YMC) were  $6.26 \pm 1.011$ ,  $5.88 \pm 0.84$ ,  $5.88 \pm 0.97$ ,  $5.98 \pm 0.73$ ,  $6.25 \pm 0.92$ ,  $7.05 \pm 0.90 \log^{10}$  cfu/ml, respectively. Significant ( $P < 0.05$ ) differences were observed between traditional and laboratory-made Dhanaan for total bacteria, coliform, non-lactic acid bacteria, and yeast and mold counts. In all cases, higher counts were observed in the traditionally made Dhanaan. The results indicate that the quality of traditional Dhanaan was poor. The results of the microbiological analysis showed that by improving hygiene during handling and processing, it is possible to improve the microbial quality of Danaan made from camel milk.

## **Activation of Lactoperoxidase System: Evaluation of the Acidification Rate, Microbial Quality, and Shelf Life of Camel and Cow Milk**

*Bekele Amenu, Mitiku Eshetu, Yonas Hailu, Egon Bech Hansen 2017. East African Journal of Sciences (EAJS) Volume 11 No.2. 2017*

Camel milk is produced in areas where there is a lack of milk cooling facilities coupled with a high ambient temperature that exacerbates milk spoilage before it reaches the ultimate market and consumers. To overcome this problem the lactoperoxidase system (LPS) is one of the methods to preserve the freshness of milk until it is marketed or reaches where there is a milk cooling facility. This study was conducted with the objectives of assessing the effect LPS activation on the preservation of raw camel and cow milk and to comparing the acidification rate of LPS activated camel and cow milk. The effect of LPS activation on inhibition of selected pathogens (i.e. *Escherichia coli* and *Staphylococcus aureus*) was also studied. The treatments consisted of a 2 x 4 factorial experiment (LPS activated and non LPS activated with 0, 6, 12, and 24 hrs storage time at 30°C treatments) in a Completely Randomized Design (CRD) with a factorial arrangement and three replications per treatment. Twenty-four camel and cow milk samples obtained from Errer valley agor-pastoralists and Haramaya University Dairy farm

respectively were examined for titratable acidity, total bacterial count (TBC), and coliform count (CC). The result revealed that titratable acidity, CC, and TBC in LPS activated milk samples were significantly lower ( $P < 0.05$ ) than their respective values in non LPS activated milk samples for both cow and camel milk, stored for 6, 12 and 24 hrs. The percent of acidity were not significantly ( $P > 0.05$ ) different than that of the initial acidity level in LPS activated cow and camel milk up to 12hrs of storage. LPS activated milk showed a bactericidal effect against TBC and CC both in cow and camel milk. In the current experiment, activation of LPS in camel milk reduced the growth rate of *E. coli* as compared to non LPS activated milk samples. The bactericidal effect of the LPS suggests that activation of the LPS would be of paramount importance in controlling the growth of microorganisms and improving the microbial quality of both cow and camel milk in the study area. Cow milk with activated LPS showed a slight delay in acidification rate compared to the non LPS activated cow and camel milk using a thermophilic starter culture. From the study, we can suggest that LPS activation of both cow and camel milk helps to extend the shelf life of fresh milk up to 6 and 12 hours, respectively, and enables milk producers to sell fresh milk within this time frame and reduce milk wastage. LPS activation can be used in improving the microbiological quality and the shelf-life of raw camel and cow milk where milk cooling facilities are not available. LPS activated milk could also be used for the manufacturing of fermented milk products.

### **Handling, Preservation, and Utilization of Camel Milk and Camel Milk Products in Shinile and Jijjiga Zones, Eastern Ethiopia**

*Eyassu Seifu. 2007. J. Livestock Research for Rural Development. 19 (6) 2007*

Traditional handling practices, preservation methods, and utilization of camel milk and camel milk products by nomadic pastoralists in Shinile and Jijjiga zones, eastern Ethiopia were assessed. A total of 73 households were interviewed on various aspects of camel milk and camel milk products using a single-visit multiple-subject diagnostic survey. All the respondents reported that camel milk is mainly consumed in its raw state in the study area. Pastoralists claim that camel milk has therapeutic property against jaundice, malaria, and constipation. Camel herders in the study area make fermented sour milk called *dhanaan* from camel milk. However, cheese and butter are not made from camel milk in the study area. Smoking of milk containers and storage of milk in a cold place is the major methods used to preserve camel milk in the area. The majority of the respondents reported that raw camel milk can be kept unspoiled for about seven days. In conclusions, camel milk has several unique properties that deserve detailed scientific investigation

### **Milk Production Performance of the One Humped Camel (*Camelus dromedarius*) under Pastoral Management in Semi-Arid Eastern Ethiopia**

*Bekele, T. Zeleke, M. and Baars R.M.T. 2002. Livest. Prod. Sci. 76 (2002): 37- 44.*

The milk production potential of camels (*Camelus dromedarius*) was studied with the objective to understand the lactation characteristics of camels in selected pastoral herds in eastern Ethiopia. The milk was measured from 61 lactating camels once in a week from October 1997 to January 2000. The mean daily milk off-take of camels was 4.14kg/day. In the first 100 days of lactation, the mean daily off-take was 4.19kg, from 101-200days was 4.86kg and decline thereafter. The daily milk off-take varied according to the number of milking per/day and ranged from 1.26kg/day for one time milking to 6.77kg/day for 4 times milking ( $p < 0.001$ ). The lactation length ranged from 224-567 days with a mean of  $353 \pm 14$  days. The mean lactation off taking

was  $1422 \pm 72$  kg. Camels in the fourth parity showed the highest mean daily average off-take (4.98 kg/day), where camels in the last parity had the lowest daily and lactation off-take. Camels that calved in the long dry season gave milk for a longer period and had a higher lactation off-take than those that calved in the short rainy season. A camel that calved in the long wet season showed the highest daily peak off-take in between nine and 19 weeks of lactation. During the long wet and short dry season, the daily off-take was above the annual mean off-take. Those camels that calf died had a significantly lower ( $P < 0.01$ ) daily total milk off-take (3.75 kg) than the camels which calf (4.22 kg) stayed alive. The daily milk off-take was significantly ( $P < 0.001$ ) different among households. In this study, the potential of camels as a dairy animal was demonstrated under traditional management, to further elucidate factors affecting the off-take capacity, studies under different management and controlled environment were recommended.

## **Milk Production Performance of Pastorally Managed Camels in Eastern Ethiopia**

*Kebebew Tuffa and Baars R.M.T. 1998. In: Proc. of 6<sup>th</sup> annual conf. Ethiopian Society of Animal Production (ESAP), 14-25 May 1998. Addis Ababa, Ethiopia. pp. 184-193.*

Milk production of 30 lactation camels belonging to one herd of 100 heads were monitored for 19 months from March 1996 to September 1997 in the Errer Valley, eastern Ethiopia. The effects of season of calving, parity and calf survival up to weaning on mean daily yield, peak yield, total lactation yield, lactation length, days open and calving interval were assessed. The least-squares mean of lactation length, day's open, and calving interval were 282, 199 and 573 days, respectively. All parameters were significantly affected by the season of calving. The maximum lactation yield was observed for camels in the third and fourth lactations. The lactation curves had a typical shape, although less pronounced for camels that calved during the long dry season. Camels that calved in the long wet season and older camels showed lower persistency. Camels whose calves died before weaning showed significantly higher yield than camels whose calves stayed alive.

## **Production, Traditional Handling, and Processing of Camel Milk in Gewane Woreda and Investigation of Camel Milk Clotting Using Selected Plant Extracts**

*Asefa Woldeyes. 2012. M.Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

This study was conducted with the objectives of assessing the traditional handling, processing, and utilization practices of camel milk in Gewane Woreda and assessing camel milk-clotting activities using crude extracts of selected plants. For the first objective, a survey was conducted among 60 camels owning households in Gewane Woreda. For the second objective, crude extracts of five plants viz., seeds of *Solanum dobium*, *Lepidium sativum*, *Trigonella foenum-graecum* and leaves of *Calotropis procera* and *Carica papaya* were prepared and their effects on clotting activities of camel and cow milk were determined at six temperature levels (50, 55, 60, 65, 70 and 80°C) and six pH level (5.0, 5.5, 6.0, 6.5, 7.0 and 8.0) using two-way factorial experiment. The effect of  $\text{CaCl}_2$  concentration at three levels (0.13 gm/l, 0.4 gm/l and 0.6 gm/l) on camel and cow milk clotting activities were determined using descriptive statistics. Milk clotting activities of five crude extracts on camel and cow milk was determined. The firmness of the curd measured using a texture analyzer. The overall average yield of camel milk in Gewane Woreda was  $5.85 \pm 1.99$  liters/day/head. The mean weaning age, age at first service, age at first calving, gestation length, calving interval, number of births per reproductive period, life expectancy, and mean lactation length of camels in Gewane Woreda were  $12.88 \pm 2.61$  months,

43.47±6.19 months, 57.0±10.03 months, 12.40±0.49 months, 27.08±4.28 months, 10.88±5.17 calves, 33.35±9.41 years and 15.15±1.89 months, respectively. The majority of the interviewed pastoral households reported that raw camel milk is the most preferred and consumed product in the area followed by sour milk. 73.3% of the households said that they give surplus camel milk for their relatives and guests. 68.3% of the households produce sour milk called Ytiqit cana. About 38.33% of the respondents wash their milk utensils, 70% put their milk in a relatively cool place, 78% of the respondents smoke utensils to maintain milk freshness. On the other hand, 40% of the households put their milk in relatively cool places, 25% smoke utensils, and 88.33% and 68% of households use plant parts (seeds) and starter to make camel milk sour, respectively. The majority of the respondents indicated that camel milk can be kept for about four to seven days. A significant difference ( $p<0.05$ ) in the clotting time of cow and camel milk was observed between the different plant extracts used in this experiment. The optimum temperature and pH of crude extracts on cow milk clotting activity ranged from 55°C - 65°C and were 6.0, respectively, whereas the optimum temperature and pH of crude extract on camel milk clotting activity ranged from 50°C - 65°C and 5.0 – 6.0, respectively. A decrease in the clotting time of cow and camel milk was observed with an increase in the temperature of the milk. pH had a significant ( $p<0.05$ ) effect on the clotting time of cow and camel milk by the plant extracts used in this experiment. A decrease in clotting time was observed with an increase in the concentration of CaCl<sub>2</sub> and temperature levels and with decreasing pH values both in camel and cow milk for all the crude extracts used. The milk clotting activities of the five crude extracts: viz., *S. dubium*, *C. papaya*, *C. procera*, *T. foenum-graecum*, and *L. sativum* was in decreasing order from *S. dubium* to *L. sativum*. The gel strength (load at yield) of cow milk was significantly ( $p<0.05$ ) higher than that of camel milk for all the coagulants used. The crude extracts of *S. dubium*, *C. papaya*, and *L. sativum* resulted in a gel strength which was equivalent to the gel strength attained by the control to (chymosin) in cow milk. However, the gel strength attained by the crude extracts of *T. foenum-graecum* and *C. procera* in cow milk were significantly ( $p<0.05$ ) lower than those attained by the control (chymosin). On the other hand, the gel strength attained by the control (chymosin) in camel milk was significantly ( $p<0.05$ ) lower than that attained by the five plant extract. Generally, the current result indicated the possibility of producing soft cheese from cow and camel milk using these five crude extracts. However, further investigation is needed in the future to extract active agents of these coagulants.

## **Milk Productivity of Camel and Growth of Calves (*Camelus dromedarius*) in Eastern Ethiopia**

*Chimsa, M. B., Mammed, Y. Y., Kurtu, M. Y. and Leta, M. U. 2014 Journal of Livestock Research for Rural Development*

Milk suckled, off-take, and growth of calves of Camel was measured from August 2008 to July 2009 in eastern Ethiopia with the aim to evaluate the performance of the herd in terms of milk productivity and growth of calves. Data on milk suckled and growth of calves was collected by methods of weight-suckle-weight. Milk off-take of the herd was measured by hand milking method. The productivity of the herd in terms of milk was evaluated based on the sum of milk suckled and off-take. The average age daily milk suckled was 2.00 ± 0.18 kg, daily milk off taking was 3.50 ± 0.14 liter, daily weight gains of calves were 0.243 ± 0.01 kg/day, respectively. Average milk productivity as the sum of milk suckled and off-take was 5.5 ± 0.16. Milk suckled, off-take, and daily weight gain of calves were affected by months of lactation, the season of births of calves, and parities of dams. Daily milk suckled, offtake and weight gain in 3-4 months of lactation were relatively higher than other months of lactation which were 2.17 + 0.22 kg, 3.55± 0.16 liter, and 0.300 ± 0.02 kg, respectively. The productivity of the herd in terms of milk

yield and growth of calves decrease as the camels advanced in lactation. Daily milk suckled, off-take and weight gain were relatively lower in 11-12 months of lactation which was 1.27+0.31 kg, 1.69 ± 0.15 liter, and 0.193± 0.02 kg, respectively.

## **Non-Genetic Factors Affecting Milk Yield and Milk Composition of Traditionally Managed Camels (*Camelus dromedarius*) in Eastern Ethiopia**

*Zelege, Z. M. 2007. Livestock Research for Rural Development (LRRD), 19 (6) 2007*

The study was conducted to assess the effects of non-genetic factors on milk yield and milk composition of camels kept under traditional management conditions in eastern arid and semi-arid areas of Ethiopia. The overall mean daily yield and composition of fat, protein, lactose, and dry matter of milk were 3.75 liters, 2.47%, 2.67%, 4.67%, and 10.44%, respectively. Stage of lactation, parity, and season of the year had significant ( $P<0.01$ ) effects on daily milk yield, the composition of fat, protein, and dry matter. The percentage composition of lactose remained unaffected by all variables considered. The highest average daily milk yield was recorded during the first 3 months of lactation ( $4.04 \pm 0.10$  liters), whereas the least was after 9 months of lactation. There was no significant difference in daily milk yield until 9 months postpartum. The percentage compositions of fat and protein were also the highest during the first 3 months of lactation period ( $3.24 \pm 0.11$  and  $2.98 \pm 0.06$ , respectively). Similarly, the highest average daily milk yield and percentage composition of protein, fat, and dry matter were recorded from camels of 3<sup>rd</sup> parity ( $5.43 \pm 0.19$  liters,  $5.32 \pm 0.44$ ,  $3.16 \pm 0.26$  and  $13.33 \pm 0.63$ , respectively). The least milk yield was obtained from camels of parity six. The highest daily milk yield ( $4.21 \pm 0.11$  liters) was recorded during the wet season as compared to the dry season ( $3.54 \pm 0.10$  liters).

## **Butter Making from Camel Milk by Blending it with Goat Milk and Analysis of its Quality**

*Aleme Asresie. 2001. M.Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

In this study, the efficiency of butter making from camel milk by blending it with goat milk, the physicochemical properties, and microbiological quality of butter made at different blending levels were assessed. The experiment was laid out in completely randomized design with five treatments, i.e., T1 (100% camel milk), T2 (75% camel and 25% goat milk), T3 (50% camel and 50% goat milk), T4 (25% camel and 75% goat milk) and T5 (100% goat milk). The milk samples were analyzed for their physicochemical properties and microbiological quality. The fat, total solids, and titratable acidity of T1 were significantly ( $P<0.001$ ) lower than T5 but T1 had significantly ( $P<0.001$ ) higher pH value than T3, T4, and T5. There was no significant ( $P>0.001$ ) difference in specific gravity between T1, T2, T3, T4, and T5. The total bacteria count (TBC) of T1 was significantly ( $P<0.001$ ) higher than TBC of T2, T3, T4, and T5. The coliform count (CC) of T5 was significantly ( $P<0.001$ ) higher than CC of the other milk samples and no significant ( $P>0.001$ ) difference was observed in CC between T1, T2, T3, and T4. The churning efficiency, physicochemical properties, and microbiological quality of the butter samples were analyzed following standard procedures. The fermentation time (11.3 days), churning time (121.7 min) and churning temperature ( $28^{\circ}\text{C}$ ) of T1 were significantly ( $P<0.001$ ) higher than the other milk samples. T1 had significantly ( $P<0.001$ ) lower churning pH (4.13) and butter yield (49.3 g/liter) than the other samples. T3 and T4 had significantly ( $P<0.001$ ) higher butter yield than the other milk samples. The fermentation time, churning time, and churning temperature of T5 was significantly ( $P<0.001$ ) shorter/lower than the rest and T5 required significantly ( $P<0.001$ ) higher churning pH than the other milk samples. The moisture

content (39.2%), melting range ( $42. \pm 1^{\circ}\text{C}$ ) and acid degree value (8.72% oleic acid) for T1 was significantly ( $P < 0.001$ ) higher than the other butter samples and T1 had significantly ( $P < 0.001$ ) lower fat content (56.8%) than the other samples. The coliform count (CC), Enterobacteriaceae count (EBC), lipolytic bacteria count (LBC), and yeast and mould count (YMC) of T1 was significantly ( $P < 0.001$ ) higher than the other butter samples. The CC, EC, and total bacteria count (TBC) of T5 was significantly ( $P < 0.001$ ) higher than T2, T3, and T4 and it had significantly ( $P < 0.001$ ) lower TBC than the others. The results showed that blending camel milk with goat milk improved fermentation and churning time and yield of butter from camel milk. Although butter can be made from pure camel milk, it took longer churning time and fermentation time.

## **Physicochemical Properties of Butter made from Camel Milk alone and Blending it with Goat milk in Eastern Ethiopia**

*Aleme Asresie, Eyassu Seifu and Mohammed Yusuf Kurtu 2013 World Journal of Animal Science Research, Vol. 1, No. 1, pp. 01- 08*

In this study, the physicochemical properties of butter made from camel milk alone and at different blending levels were assessed. The experiment was laid out in completely randomized design with five treatments, T1 (100% camel milk), T2 (75% camel and 25% goat milk), T3 (50% camel and 50% goat milk), T4 (25% camel and 75% goat milk) and T5 (100% goat milk). The physicochemical properties of the butter samples were analyzed following standard procedures. The moisture content (39.2%), melting range ( $42.10^{\circ}\text{C}$ ), refractive index (1.592) and acid degree value (8.72% oleic acid) for T1 was significantly ( $P < 0.001$ ) higher than the other butter samples and T1 had significantly ( $P < 0.001$ ) lower fat content (56.8%) than the other samples. The results showed that blending camel milk with goat milk improved physicochemical properties of butter made from camel milk at different blending levels.

## **Churning Efficiency and Microbial Quality of Butter made from Camel Milk alone and blending it with Goat Milk.**

*Aleme Asresie, Eyassu Seifu, and Mohammed Y. Kurtu 2013 Net Journal of Agricultural Science, Vol. 1(3), pp. 75-80,*

In this study, the churning efficiency of milk samples for butter making from camel milk by blending it with goat milk and microbiological quality of butter made at different blending levels were assessed. The experiment was laid out in completely randomized design with five treatments: T1 (100% camel milk), T2 (75% camel and 25% goat milk), T3 (50% camel and 50% goat milk), T4 (25% camel and 75% goat milk) and T5 (100% goat milk). The churning efficiency and microbiological quality of the milk and butter samples were analyzed following standard procedures. The fermentation time (11.33 days), churning time (121.7 min) and churning temperature ( $28^{\circ}\text{C}$ ) of T1 were significantly ( $P < 0.001$ ) higher than the other milk samples. T1 had significantly ( $P < 0.001$ ) lower churning pH (4.13) and butter yield (49.3 g/L) than the other samples. T3 and T4 had significantly ( $P < 0.001$ ) higher butter yield than the other milk samples. The fermentation time, churning time, and churning temperature of T5 was significantly ( $P < 0.001$ ) lower than the rest and T5 required significantly ( $P < 0.001$ ) higher churning pH than the other milk samples. The coliform count (CC), Enterobacteriaceae count (EBC), lipolytic bacteria count (LBC), and yeast and mould count (YMC) of T1 was significantly ( $P < 0.001$ ) higher than the other butter samples. The CC, EC, and total bacteria count (TBC) of T5 were significantly ( $P < 0.001$ ) higher than T2, T3, and T4 and it had significantly ( $P < 0.001$ ) lower TBC than the others. The results showed that blending camel milk with goat milk improved the churning efficiency and microbial quality of butter made from

camel milk at different blending levels. Although butter can be made from pure camel milk, it took longer churning time and fermentation time. Thus, research is needed to reduce the churning time, improve the yield of butter and microbial quality made from pure and blended camel milk by manipulating the operating parameters viz., pH of the milk, churning temperature, method of churning and volume of milk in the churn.

### **Isolation and Characterization of Lactic Acid Bacteria from Ititu: Ethiopian Traditional Fermented Camel Milk**

*Eyassu Seifu, AryaAbraham., M. Y. Kurtu and ZelalemYilma. 2012. Journal of Camelid Science, 5: 82-98*

This study was aimed at the isolation and characterization of lactic acid bacteria from traditional fermented camel milk called *Ititu*. Twenty samples of traditionally fermented camel milk *Ititu* used for the experiment were obtained from camel herders in the *Kereyu* area in Eastern Ethiopia. A total of 146 colonies grown on MRS and M17 agar were subjected to different screening tests and identified as presumptive lactic acid bacteria and classified to the genera *Lactobacillus* (85), *Lactococcus* (36) and *Enterococcus* (25). The isolated species of lactic acid bacteria were *Lactobacillus Plantarum* (32%), *Lactobacillus delbrueckii* subsp. *bulgaricus* (17%), *Lactobacillus salivarius* (9%), *Lactococcus lactis* subsp. *lactis* (18%), *Lactococcus lactis* subsp. *cremoris* (7%) and *Enterococcus faecalis* (17%). Among the isolated lactic acid bacteria species, *Lactobacillus salivarius* produced the highest amount of acid at a relatively faster rate than the other isolates. From the present study it can be suggested that with further study on technological properties, the isolated lactic acid bacteria species could be considered as potential candidates for the development of starter cultures that can be used for the production of fermented camel milk products under controlled condition.

### **A Review on Lactic acid Bacteria in Indigenous Traditionally Fermented Camel Milk of Ethiopia**

*Estifanos Hawaz. 2014. International Journal of Microbiology Research and Reviews.  
Vol. 3 (1), pp. 122-126.*

This research review aimed at the analysis of lactic acid bacteria (LAB) studies of Ethiopian indigenous traditionally fermented camel milk food products. Lactic acid bacteria (LAB) have a very long history of use in the manufacturing processes of dairy fermented foods. In the eastern part of Ethiopia, farmers and pastoralists produce indigenous traditionally fermented camel milk products including *dhanaan* and *ititu*. Fermentation of *dhanaan* and *ititu* is carried out by mesophilic lactic acid bacteria. Lactic acid bacteria are a broad group of Gram-positive organism and are mainly used as a starter strains, predominantly, *Streptococcus thermophilus*, *Lactobacillus lactis*, *Lactobacillus helveticus*, and *Lactobacillus delbrueckii* subsp. *Bulgaricus* is widely used as dairy starter cultures. Genus *lactobacillus*, genus *lactococcus*, and genus *enterococcus* bacteria involved in the fermentation of *ititu*. *Lactobacillus salivarius*, *Lactobacillus Plantarum*, *Lactobacillus delbrueckii* subspecies *bulgaricus*, *Lactococcus lactis* subspecies *lactis*, and *Enterococcus faecalis* are the isolated lactic acid bacteria species from *ititu*.

## **Quality and Safety of Camel Milk along the Value Chain in Eastern Ethiopia**

*Mulugojjam Adugna, Eyassu Seifu, Ameha Kebeded and Reiner Doluschitz. 2013. International Journal of Food Studies (IJFS), Vol. 2, pp. 150-157*

The safety of camel milk was assessed along the value chain in Erer, eastern Ethiopia. A total of 24 camel milk samples were aseptically collected from producers in Erer (n=12), and wholesalers and retailers (n=12) along the chain. Milk quality parameters were analyzed following standard procedures. The mean (SD) total bacteria (TBC), Enterobacteriaceae (EC), coliform (CC), spore-forming bacteria (SFBC) and yeast and mould (YMC) counts of the milk samples analyzed were 5.2 1.90, 3.2 2.30, 2.9 2.27, 2.1 2.41 and 2.7 1.61 log<sub>10</sub> cfu ml, respectively. The TBC, EC, CC, and SFBC of milk samples obtained from retailers in the marketing sites were significantly higher (P<0.05) than those obtained from producers and wholesalers in Erer. Salmonella spp. was detected in milk samples collected from all sites. Other microorganisms isolated from camel milk samples include Staphylococcus aureus (16.2%), Enterobacter spp. (14.9%), Streptococcus spp. (13.5%), Escherichia coli (8.1%), Acinetobacter spp. (7.4%), Staphylococcus epidermidis (6.8%), Klebsiella spp. (6.1%), Bacillus spp. (5.4%), Corynebacterium spp. (5.4%), Micrococcus spp. (4.7%), Lactobacillus spp. (4.1%), Listeria spp. (4.1%), Pseudomonas spp. (2%) and Shigella spp. (1.4%). The quality of camel milk produced in the study area was generally poor and microbial contamination of camel milk occurs along the value chain while it is transported from the production site to the market.

## **Physicochemical and Microbiological Quality of One Humped Camel (*amelus dromedarius*) Milk**

*Mulugojjam Adugna and Aleme Asresie. 2014 Review Article Journal of Biology, Agriculture and Health care, Vol.4, No. 23, 2014, pp.118-124*

The objective of this paper is to review researches conducted on the physicochemical and microbiological quality of camel milk. Milk is a complex biological fluid secreted by mammals for the nourishment and to provide immunological protection for their young. Milk is considered a complete food because it contains proteins, fat, carbohydrates, minerals, vitamins, and water. Camel milk is the main food especially for those who live in arid zones and also it can be produced in a large amount in dry areas than other livestock. Even if there are many factors that can affect milk composition including breed variation (within a species, herd to herd), management, feed considerations, seasonal variation, geographic variations, and stage of lactation. Camel milk is highly nutritious. The quality of milk can be affected due to physical, chemical, and microbiological factors.

## **Milk Production, Fluid Balance and Temperature Regulation in Lactating Camels (*Camelus dromedarius*)**

*Bekele Tafese. 2010. Ph. D. Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden*

The aims of this thesis were to identify good milking and watering routines for camels and to better understand the physiological mechanisms that enable camels to produce milk during long periods of water deprivation. Milk production was increased by changing the number of milking from one to four times per day in an on-farm study. Camels that calved in the long dry season had a higher lactation yield than those that calved in the wet season. Seven camels were subjected to four watering regimes, each 16 days long with 5 days of daily watering in between. The regimes were: water offered once every day (W1); offered on days 4, 8, 12, and 16 (W4); on days 8 and 16 (W8) or on day 16 (W16). Milk yield decreased after about 8 days of water



deprivation, and changes in milk fat, lactose, and protein concentrations remained small during W16. Contrary to widespread belief, dehydrated camels did not dilute their milk, instead, milk and blood plasma osmolality increased in parallel. Camels saved water by storing heat during daytime allowing body temperature to increase and dissipating the heat during the cool night. Afternoon body temperature was around 39.0°C in all treatments but fell by 3 to 6°C at night, with the lowest recorded values in severely dehydrated camels. Despite low morning body temperatures, camels sought shade to avoid evaporative water loss but after drinking, they spent more time in the sun. Water deprived camels are known to compensate the number of kilograms of body weight lost by drinking an equivalent number of liters of water, and this has been assumed to indicate a full recovery. However, diminished food and salt intake, and sodium loss via urine and feces, are seldom considered. During dehydration, W16 camels increased plasma vasopressin levels, which decreased upon drinking, but aldosterone concentration increased to retain sodium, and camels took more than two weeks to recover. Camels maintained milk production during 8 days of water deprivation, to improve milk production, more frequent watering is recommended in the dry season.

### **Milk Production and Feeding Behavior in the Camel (*Camelus dromedarius*) During Four Watering Regimens in Eastern Ethiopia**

*Bekele, T., Lundeheim, N. and Dehlborn, K. 2011 J. American daily Science Association*

Camels survive and produce milk during recurrent prolonged hot and dry periods. The objective was to evaluate how different watering intervals affected milk production and feeding. Eight lactating camels (*Camelus dromedarius*) were recruited and subjected to 4 watering regimens in a Latin square design experiment performed at Haramaya University in Ethiopia. Each regimen lasted 16 d (days) with 5 d of daily watering between periods: water was offered at 1,315 h once daily (W1); on d 4, 8, 12, and 16 (W4); on d 8 and 16 (W8); and on d 16 (W16). One camel became sick in the second period and its results were excluded. Camels were kept in a pen with minimal shade and a noon temperature of 30.9±0.1°C. They had free access to hay and were offered 2 kg of concentrates 3 times daily. At noon on d 1, 4, 8, 12, and 16, a blood sample was taken from the jugular vein before watering. All calves were kept together in a separate pen. Morning and afternoon calves stimulated milk let-down before the camels were hand-milked, after which the calves suckled, emptying the udder. Camels maintained the milk volume during water deprivation for about 1 week, but they produced less milk during the second week during W16. Morning milk osmolality increased from 315±3 on d 1 to 333±3 mosm/kg on d 4 during W4 and from 321±3 on d 1 to 342±3 mosm/kg on d 8 during W8. After watering at 1315 h, milk osmolality decreased to 316±3 and 323±3 mosm/kg, respectively, the same afternoon and then increased during recurrent water deprivation to 338±3 (W4) and 347±3 mosm/kg (W8) on d 16, respectively. During W16, osmolality increased from 318±3 to 336±3 mosm/kg during the first 4 d of water deprivation, but during the remaining 12 d, the further rise in osmolality was not higher compared with that on d 4. The change in milk osmolality was linearly correlated to plasma osmolality (r=0.8), but milk lactose content did not increase. Contrary to widespread belief, camels did not dilute their milk when dehydrated. Instead, milk osmolality increased in parallel to blood osmolality. This study provides further support to earlier observations on camels' adaptation to their environment.

## **Functional and Technological properties of Camel Milk Proteins: A Review Article**

*Yonas Hailu , Egon Bech Hansen , Eyassu Seifu and Mitiku Eshetu, 2016.*

*J Dairy Res. 2016 Nov; 83(4):422-429.*

This review summarises current knowledge on camel milk proteins, with a focus on significant peculiarities in protein composition and molecular properties. Camel milk is traditionally consumed as a fresh or naturally fermented product. Within the last couple of years, an increasing quantity is being processed in dairy plants, and a number of consumer products have been marketed. A better understanding of the technological and functional properties, as required for product improvement, has been gained in the past years. Absence of the whey protein  $\beta$ -LG and a low proportion of  $\kappa$ -casein cause differences in relation to dairy processing. In addition to the technological properties, there are also implications for human nutrition and camel milk proteins are of interest for applications in infant foods, for food preservation and in functional foods. Proposed health benefits include inhibition of the angiotensin-converting enzyme, antimicrobial, and antioxidant properties as well as an antidiabetogenic effect. Detailed investigations on foaming, gelation, and solubility as well as technological consequences of processing should be investigated further for the improvement of camel milk utilization in the near future.

## **Processing Challenges and Opportunities of Camel Dairy Products: Review Article**

*Berhe, T., Seifu, E., Ipsen, R., Kurtu, M. Y., & Hansen, E. B. 2017.*

*International Journal of Food Science and Technology, 2017, [9061757]. DOI: 10.1155/2017/9061757.*

A review of the challenges and opportunities of processing camel milk into dairy products is provided with the objective of exploring the challenges of processing and assessing the opportunities for developing functional products from camel milk. The gross composition of camel milk is similar to bovine milk. Nonetheless, the relative composition, distribution, and the molecular structure of the milk components are reported to be different. Consequently, manufacturing of camel dairy products such as cheese, yoghurt, or butter using the same technology as for dairy products from bovine milk can result in processing difficulties and products of inferior quality. However, scientific evidence points to the possibility of transforming camel milk into products by optimization of the processing parameters. Additionally, camel milk has traditionally been used for its medicinal values and recent scientific studies confirm that it is a rich source of bioactive, antimicrobial, and antioxidant substances. The current literature concerning product design and functional potential of camel milk is fragmented in terms of time, place, and depth of the research. Therefore, it is essential to understand the fundamental features of camel milk and initiate detailed multidisciplinary research to fully explore and utilize its functional and technological properties.

## **Microbiological Quality of Raw Cow Milk across the Milk Supply Chain in Eastern Ethiopia**

*Tadele Amentie, Ameha Kebede, Yoseph Mekasha, Mitiku Eshetu. 2016.*

*East African Journal of Sciences Vol 10, No 2 (2016)*

The risk of milk contamination with spoilage and pathogenic microorganisms is high for milk produced in developing countries like Ethiopia especially in the lowland region as their milk

production practices are a traditional type that lacks appropriate hygienic control. To protect the raw cow milk from spoilage loss and consumers from milk born public health risk, the availability of documented information on the microbiological quality of raw milk across the milk supply chain is critically important as such information may be important for different organization to undertake relevant development intervention on hygienic practices essential for safe milk production and handling. This study was, therefore, conducted to determine the microbiological quality of informally marketed raw cow milk across the milk supply chain in eastern Ethiopia. A total of 360 pooled raw cow milk samples (each with a volume of 450 mL) were collected from udders and milk handling equipment of producers in rural areas of Babile district; from the equipment of collectors/transporters in Harar and Dire Dawa towns as well as from the equipment of vendors and consumer at Babile, Harar and Dire Dawa towns during February 2014 to January 2015. The milk samples were subjected to laboratory analyses to evaluate total aerobic mesophilic bacteria count (TAMBC), total coliform count (TCC), yeast count (YC) and mold count (MC) in the laboratory to determine the microbiological quality of the milk. Mean TAMBC, TCC, YC and MC for raw cow milk samples collected directly from the udders were  $6.02 \pm 0.14$ ,  $4.23 \pm 0.12$ ,  $2.57 \pm 0.10$  and  $2.67 \pm 0.10 \log_{10} \text{ cfu mL}^{-1}$ , respectively. The values for the samples collected from the equipment of producers upon arrival at their selling points were  $7.17 \pm 0.14$ ,  $5.86 \pm 0.12$ ,  $3.46 \pm 0.10$ , and  $3.70 \pm 0.10 \log_{10} \text{ cfu mL}^{-1}$  for TAMBC, TCC, YC, and MC, respectively. Mean TAMBC, TCC, YC and MC for samples collected from the equipment of collectors/transporters were  $7.96 \pm 0.10$ ,  $6.49 \pm 0.07$ ,  $3.99 \pm 0.07$  and  $4.37 \pm 0.07 \log_{10} \text{ cfu mL}^{-1}$ , respectively. The microbial counts for samples collected from the equipment of vendors were  $8.78 \pm 0.08$ ,  $7.32 \pm 0.07$ ,  $4.98 \pm 0.06$  and  $5.04 \pm 0.07 \log_{10} \text{ cfu mL}^{-1}$  for TAMBC, TCC, YC, and MC, respectively. The values for samples collected from the equipment of consumers were  $8.82 \pm 0.08$ ,  $7.37 \pm 0.07$ ,  $5.10 \pm 0.06$ , and  $5.11 \pm 0.07 \log_{10} \text{ cfu mL}^{-1}$  for TAMBC, TCC, YC, and MC, respectively. It could be concluded that raw cow milk samples collected from all towns and milk sources were severely contaminated with aerobic mesophilic and coliform bacteria, yeast, and molds, with loads exceeding the respective acceptable limits.

## **Milk postharvest handling practices across the supply chain in Eastern Ethiopia**

*Amentie T, Eshetu M, Mekasha Y, Kebede A. 2016.*

*Milk postharvest handling practices across the supply chain in Eastern Ethiopia  
Journal of Advanced Veterinary and Animal Research, 3(2): 112-126.*

This study was conducted to assess hygienic cow milk handling practices of milk producers, traders (informal collectors, transporters, and vendors), and consumers across the milk supply chain in Eastern Ethiopia. Materials and methods: A total of 160 milk producers in Babile district were selected using a multistage stratified sampling technique. Moreover, a total of 54 milk collectors and transporters (5, 40, 9 from Jigjiga, Harar and Dire Dawa town, respectively), 152 vendors (40 from Bable, Harar and Dire Dawa town and 32 from Jigjiga town) and 160 consumers (40 from each town) were selected using a snowball sampling technique. Data from the selected actors were collected using focus group discussion, questionnaire surveys, and observations. Results: The study revealed that the majority of milk handling operations in the study area is carried out by females. The majority of respondents milk producers (87.5- 92.5%), collectors and transporters (88.9-100%), vendors (77.5-90.7%), and some consumers (37.5-47.5%) performing milk handling operations were illiterate. Most of the observed actors in the study area perform malpractices (such as failure to stop milk handling while showing disease symptoms, improper hand washing, and handling of risk factors) while working with milk. The majority of respondent milk producers (87.5- 97.5%), all traders, and some consumers (12.5-32.5%) use plastic containers for milk handling. Milk handling equipment was commonly

washed using warm water, detergent, and sand; however, in most cases, they were not properly protected from risk factors after washing. The majority of respondent milk producers (55-65%), collectors and transporters (60-66.7%), and some vendors (0-50%) and consumers (0-55%) use water from non-tap sources for hygienic practices. Conclusion: In general; the findings indicated that milk handling practices performed across the supply chain in the study area were unhygienic and therefore suggested the need for improving hygienic practices.

## **Coagulation of Camel Milk using Crude Ginger (*Zingiber officinale*) Rhizome and evaluation of its Effect on Properties of Soft Unripened Cheese**

*Yonas Hailu. 2012. MSc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

This research was conducted with the objective of assessing the clotting activity of camel milk using crude extracts of ginger rhizome (*Zingiber officinale*), to identify the optimum pH, temperature and concentration of the crude extracts that would result in strong coagulation of camel milk for camel milk cheese making and to assess the effect of ginger crude extract on the quality of soft unripened cheese made from camel milk. Factorial arrangement of 3\*3\*4 (3 temperature (55°C, 60°C and 65°C) and pH (4.5, 5.0 and 5.0) conditions each and 4 levels of crude extract concentration (0.1, 0.2, 0.3 and 0.4 ml/ml) with Completely Randomized Design (CRD) was used to analyze clotting activity data. Curd firmness, cheese quality, and sensory evaluation data were analyzed using CRD. In addition, the physicochemical properties of raw camel milk was also studied. Cow milk was considered for comparison of Milk clotting activity (MCA). Each experiment was conducted in triplicates. Temperature, pH, and concentration of crude extract had a significant effect on the clotting activity of camel milk. The highest camel MCA was observed at pH of 5.0, the temperature of 65°C and crude extract concentration of 0.1 ml/ml, while the lowest camel MCA was at pH 4.5, temperature 55°C and crude extract concentration of 0.4 ml/ml. The highest clotting activity on cow milk was observed at a pH of 5.5, the temperature of 60°C, and ginger crude extract concentration of 0.1 ml/ml. Camel MCA increased as milk pH is reduced from 5.5 to 5.0 and then decreased as pH is reduced to 4.5. MCA increased with increasing temperature. Clotting activity decreased with increasing crude extract concentration. The temperature, pH, and crude extract concentration combination that resulted in the highest milk clotting activity can be considered as an optimum point for making soft unripened cheese from camel milk. Camel milk used for cheese making had 6.64 pH, 0.147% titratable acidity (TA), 11.6% total solids (TS), 0.94% ash, 3.0% fat and 2.9% protein contents. On average, the cheese made using ginger crude extract had 4.87 of pH and 0.814% of TA, while cheese made using camel chymosin had pH of 5.27 and TA of 0.571. Cheese made using ginger crude extract contains 35.4% TS, 2.10% ash, 12.9% fat, and 16.4% protein, while cheese made from camel chymosin had 39.9% TS, 1.98% ash, 13.4% fat and 19.7% protein. Using camel chymosin resulted in higher actual cheese yield as compared to ginger crude extract (11.4 vs 8.7 kg cheese/100 kg milk) in which fine curd particles escape to whey during soft unripened cheesemaking using the ginger extract. Sensory score of soft unripened cheese made using the ginger crude extract for color (5.20), appearance (4.70), aroma (5.93), taste (5.0), texture (4.83) and overall acceptability (5.23), while, soft unripened cheese made using camel chymosin resulted in higher sensory attributes score except aroma (5.20); sensory scores for color (6.50), appearance (6.17), taste (5.70), texture (5.67) and overall acceptability of 6.74 for cheese made using camel chymosin. The results obtained from clotting activity and cheese making indicate substantial coagulation of camel milk using ginger crude extract and it can be used for making soft unripened cheese from the milk of camel. The study result has also indicated quality and consumer acceptability of soft unripened camel milk cheese was determined by coagulant type.

## **Physicochemical Properties and Consumer Acceptability of Soft Unripened Cheese Made from Camel Milk Using Crude Extract of Ginger (*Zingiber officinale*) as Coagulant**

Yonas Hailu, Eyassu Seifu and Zelalem Yilma. 2014  
*Afr. J. Food Sci. Technol.* Vol. 8(2), pp. 87-91

This study was conducted to analyze the quality attributes of Soft Unripened Cheese (SUC) made using ginger (*Zingiber officinale*) crude extract (GCE) by comparing it with cheese made using Camel Chymosin (CC). SUC made using GCE had higher acidity and ash but lower fat, total solids, and protein as compared to cheese made using CC. The camel chymosin resulted in higher cheese yield as compared to cheese made using GCE. Although lower than the values for cheese made using CC, sensory scores of cheese made using GCE is in line with literature values for camel milk cheese. The results indicated that GCE can be used to coagulate camel milk and thus help make cheese from camel milk.

## **Clotting Activity of Camel Milk using Crude Extracts of Ginger (*Zingiber officinale*) Rhizome**

Yonas Hailu, Eyassu Seifu, and Zelalem Yilma 2014. *Afr. J. Food Sci. Technol.*  
Vol. 5(3) pp. 90-95

This study was conducted to assess the clotting activity of camel milk using ginger rhizome (*Zingiberofficinale*) crude extracts (GCE) and identify the optimum pH, temperature, and concentration of GCE that would result in strong coagulation of camel milk. The result revealed that temperature, pH, and concentration of GCE had a significant ( $P<0.05$ ) effect on the clotting activity of camel milk. The highest camel MCA was observed at pH of 5.0, temperature of 65°C and crude extract concentration of 10% by volume of milk, while the lowest value was recorded at pH of 4.5, temperature 55°C, and GCE concentration of 40% by volume of camel milk. Cow milk was considered for comparison of MCA and had the highest clotting activity at a pH of 5.5, the temperature of 60°C and GCE concentration of 10% by volume of milk. An increase in camel MCA was observed with a decrease in milk pH from 5.5 to 5.0; however, camel MCA decreased when milk pH reduced to 4.5. Camel MCA increased with increasing temperature; however, it decreased with an increase in GCE concentration. Hence, GCE can be used to coagulate the camel by adjusting the temperature and pH of the milk.

## **Udder Health and Milk Quality among Camels in the Errer Valley of Eastern Ethiopia**

Sh-Abdurahman, O. A. 2006. *Livestock Research for Rural Development (LRRD)*.18 (8) 2006.

Quarter milk samples (n=205) from 53 camels were examined to study the occurrence and causes of mastitis in traditionally managed camels in the Errer valley of eastern Ethiopia and to observe factors affecting udder health. The study revealed tick infestation and lesions on the teats and udder skin 26 (49,1%). Seven (3.3%) camels had blind teats and 5(9.4%) had clinical mastitis. Seventy-seven (37.6%) quarters yielded bacteria. *Staphylococcus aureus*, *Streptococcus agalactiae*, and coagulase-negative staphylococci were the main organisms isolated. A high proportion (80%) of bacteria positive milk samples had CMT score 2 or more, while a similar proportion (80%) of bacteriologically negative samples showed CMT score 1. Quarters infected with bacteria had significantly higher mean values for somatic cell

counts than non-Infected ones log12.5 and 13.6 respectively. The demographic parameters of age, parity, and lactation stage did not influence the ability to predict whether a quarter was normal when judged on percentage correctly classified. The significance of the findings in relation to the production system, hygiene, and public health aspects was discussed. It is, therefore, cheaper and easier to prevent mastitis by improving hygienic measures than to treat by medication. The cost of the latter includes a veterinary fee, cost of medicine, and loss of milk production. It is concluded that early problem recognition and improved hygienic measures will result in reduced losses due to mastitis and increase the availability of milk for consumption and sale.



# Part III

# Breeding



Photo credit: Sisav Tilahun







# **Phenotypic Characterization and Traditional camel (*Camelus dromedaries*) Selection and Breeding Practices in Pastoral Communities of Jarar and Korahey zones, Ethiopian Somali Regional State**

*Hassen A., Yosef T., Mengistu U.2018. MSC Thesis, Haramay University, Dire Dawa, Ethiopia*

This study was carried out in Jarar and Korahey zones of Ethiopian Somali Region with the objectives to phenotypically characterize the indigenous camel population in the area, identify the camel traditional breeding strategies, objectives, and challenges. Field study and data collection were done through questionnaires, focus group discussions, observations, and linear body measurements taken from sample camels in the study areas. A total of 360 household head camel owners and 420 mature camels (360 females and 60 Males) randomly selected from six purposively selected study districts from the two zones were used. Results showed that the average camel number per household was higher in Sheykosh ( $94\pm 11.5$ ), followed by Kebridehar ( $77\pm 6.8$ ) and Gashamo ( $60\pm 5.1$ ) woreda. The average proportion of female camel above one year of age in a herd ranges from 56.9 to 62% while the total average proportions of female camel per household including female calves range from 75 to 80.9% in the study areas. The larger proportion of female camels shows that milk production is the priority trait of interest for the pastoral communities and indicates their breeding objective of ensuring the continuous supply of milk to the family. The overall mean milk production performance in the study areas in terms of lactation length and milk offtake during wet and dry seasons was  $12.79\pm 2.3$  months,  $6.36\pm 0.085$  kgs/day/camel and  $3\pm 0.04$  kgs/day/camel, respectively. Similarly, the reproductive performance in terms of Reproductive Life Time (RLT) of male and female camels, age at first mating (AFM) of male and female camels, age at first calving (AFC) and Calving Interval (CI) of female camels were  $17.92\pm 4.2$  and  $20.03\pm 2.6$  years,  $5.95\pm 0.3$  and  $4.22\pm 0.21$  years,  $5.26\pm 0.23$  years and  $23.13\pm 4.3$  months, respectively. Pastoral camel owners in the study areas practice selection only for male camels based on the male camels or ancestors' ability to give birth to more female offspring (38.3%), color and appearance of male camel (27.2%), size and body condition (21.1%), libido (8.9%) and growth (4.4%) traits. Five distinct camel breed types namely Hoor, Gellab, Aidin, Ayun, and Ayro inhabiting the study zones were identified. Pairwise comparisons of all five-camel breed types for 17 morphometric traits showed a significant ( $P<0.05$ ) difference among the breed types. Gellab camel breed types have significantly ( $P<0.05$ ) higher Shoulder Height (SH), Neck Length (NL) and Ear Length (EL) whereas Aidin breed types exhibited a significantly ( $P<0.05$ ) higher Hearth Girth (HG), Chest Depth (CD), Tail Length (TL), Hump Length (HL) and Estimated Live Body Weight (ELBWt) and the Ayro camels possess significantly ( $P<0.05$ ) higher Chest Width (CW), Fore Leg Length (FLL) and Hump Circumference (HC) than any of the other camel breed types. The greatest morphological divergence was recorded between Aidin and Ayro breed types followed by Aidin and Gellab while the least divergence was recorded between Hoor and Ayun followed by Hoor and Aidin. Pastoral camel owners in the study area categorized Hoor, Gellab, and Ayun camel breed types as pure and Aidin and Ayroas crossbreds. Aidinis a crossbred from Hoor and Gellab while Ayrois cross from Hoor and Ayun. Even though such camel genetic resource diversities exist in the study area, the traditional breeding practices of only selecting male camel (stud) for breeding instead of both male and female camels and using the male camel (Stud) for longer breeding periods might result in genetic erosion as a result of inbreeding effects. Therefore; raising the pastoral communities' awareness and knowledge on inbreeding and designing and implementing improved camel breeding programs has paramount importance and recommended as far as sustainable utilization of camel genetic resources in the area is concerned.

## **Genetic Variability and Relationship of Camel (*Camelus dromedarius*) \_Populations in Ethiopia as Evidenced by Microsatellites Analysis**

*Yosef T., V. Costa, Zelalem G.M., Mengistu U., Sisay T., Keefelegn K., Mohammed Y. K, Solomon A., Tadelle D., Beja-Pereira A.*

This study was carried out to assess the genetic diversities and population structure of six camel populations of Ethiopia. Blood samples were collected from 114 camels (17-24 per population) and genotyped using 10 camel microsatellite marker loci. The result revealed high genetic diversities in Ethiopian camel populations with average observed and expected heterozygosity, the total number of alleles (TNA), mean number of alleles (MNA), and effective number of alleles of 0.55, 0.73, 153, 6.8 (0.36) and 4.47(0.23), respectively. Among the 52 private alleles in the six Ethiopian camel populations, 31 of them were occurring at a frequency of  $\geq 5\%$ . It was also found that most of the variation in Ethiopian camels is attributed to within-population variation (92%) while 8% was explained by between populations variation. Even though there was high heterozygosity, a high inbreeding coefficient was detected within a population ( $F_{IS}=0.242(\pm 0.04)$ ) and total populations ( $F_{IT}=0.322\pm (0.04)$ ). The between-population differentiation was ( $F_{ST}=0.105(0.01)$ ) indicating moderate population differentiation. The neighbor-joining tree and structure analysis show that the Ethiopian camel populations were clustered into four subgroups. The Afar camels were grouped into two together with the Ethiopian Somali camels (Jijiga with Mille and Gelleb with Amibara) and the two Ogaden camels (Liben and Hoor) are separated into two subgroups indicating that some of the Afar and the Somali camel breeds were admixed. Therefore, even though high heterozygosity within the population and moderate genetic differentiation between populations were observed, the presence of a high inbreeding coefficient may affect heterozygosity in the overall populations. Three of the models (IAM, TPM, and SMM) and two of the tests (Wilcoxon- and sign test) shows that occurrence of a genetic bottleneck ( $P<0.05$ ) in Jijiga camel population in the recent past, whereas the result of the IAM model and the two tests, showed the occurrence of a genetic bottleneck for Mille, Amibara, Hoor and Gelleb but the result of the other two models (TPM and SMM) were in discordance with IAM model.

# **Camel and Cattle Population Dynamics and Livelihood Diversification as a Response to Climate Change in Pastoral Areas of Ethiopia**

*Yosef, T., Mengistu, U., Solomon A., Mohamed Y. K., and Keefelegn, K. 2013  
Livestock Research for Rural Development (LRRD)*

The objective of this study was to assess camel and cattle population dynamics and its implication on species conservation, and livelihood diversification of pastoralists. Cattle and camel population dynamics and household *incomes* were quantified using herd histories and interviews of pastoralist households that inhabit Afar, Oromiya, and Somali National Regional States (NRS) of Ethiopia. From each NRS two-four districts were selected based on camel and cattle population and accessibility and from each district, 25-32 pastoralist households were selected using stratified random sampling by considering wealth status. Thus, a total of 200 interviewees were involved in the study. Pastoralists faced five to seven drought periods during the past 30 years and lost 45-70% of their cattle in each of the periods. As a consequence, the pastoralists developed considerable interest in camel production and livelihood diversification as a mitigation strategy to climate change. Camel population increased during the past 20 years by 10, 20, 25, 15, 25, and more than 200% respectively in Gode, Jigjiga, Shinille, Mille, Amibara, and Borena Districts. On the contrary, the cattle population decreased from 50-70% in most of the study districts during the past 20 years. Currently, 13.8, 25, 10.4, and 7.8% of the interviewed households in Gode, Jigjiga, Shinille, and Borena Districts, respectively do not possess cattle. The study showed that livelihood diversification is practiced by about 15-35, 20-25, and 5-10% of pastoralists in Somali, Borena, and Afar, respectively. All interviewed pastoralists favor the increment of a camel. All interviewed pastoralists in Jigjiga, Mille, and Borena Districts have a plan to reduce cattle numbers in the herd in the future. Most of the interviewed pastoralists in Gode and Shinille Districts favor the reduction of cattle numbers in the herd. The majority of pastoralists in Amibara District started crossing the local cattle with other indigenous Kereyu cattle breed type as a mitigation strategy to climate change since the later is believed to be better adapted to the arid environment. Pastoralists and agro-pastoralists are engaged in off-farm activities such as selling firewood and charcoal, and petty trading to diversify income. Accordingly, 15-20, 20-25, and 5% of pastoralists and agro-pastoralists in Somali (Gode, Jigjiga, and Shinille), Borena (Yabelo and Moyale) and Afar (Amibara and Mille), respectively are engaged in different off-farm activities. - In general, the results showed that cattle population is decreasing from time to time, while camel population is in increasing trend in arid and semi-arid areas as a result of the combined effects of pastoralist needs and the impact of climate change, which could position the indigenous cattle breed at risk in the near future. Climate change in these sites was expressed as recurrent drought, extreme temperature, and replacement of grazing lands by bush encroachment and loss of disease resistance livestock species and others. Therefore, appropriate restocking, quick identification and implementation of conservation strategies of pastoral cattle breeds, and creating access to on the farm and off-farm activities through strategic projects in the region are important to diversify pastoral household income and sustainably utilize cattle breeds.

## **Study on Live Weight, Carcass Weight and Dressing Percentage of Issa Camels in Ethiopia**

*Abebe, W., Getinet A.M. and Mekonnen H.M. 2002 J.*

*Revue Med.Vet.153 (11): 713-716.*

An attempt was made to determine the live weight, carcass weight, and dressing percentage of Issa camels of various age groups raised under natural field conditions. The mean live weights estimated from Barymetric measurements (shoulder height, thoracic and abdominal girth) were  $131.9 \pm 20.3$  kg (for calves less than 1 year of age),  $211.6 \pm 20.2$  kg (1- 3 years of age),  $294.6 \pm 13.3$  kg (3 - 6 years of age),  $355 \pm 25$  (6 - 10 years of age) and  $425.9 \pm 6.9$  kg (older than 10 years of age). A strong positive correlation was obtained between live weight estimates and barymetric measurements, the superior being with thoracic girth ( $r = 0.96$ ). Issa camels slaughtered at Dire Dawa slaughterhouse had an average carcass weight of 233.4 kg and a dressing percentage of 52.7 %. The positive correlation effect was confirmed between live weight and dressing percentage ( $r = 0.77$ ) and between carcass weight and dressing percentage ( $r = 0.47$ ). While a negative relationship was found between live weight and dressing percentage ( $r = -0.2$ ). Forequarters followed by the hindquarters constitute the highest proportion of the carcass in relation to the live body weight and whole carcass. The present finding obtained on the live weight, carcass weight and dressing percentage of Issa camels can serve as a guide for any studies related to the productivity of this animal and in proper dose calculations of many therapeutic drugs used in treating diseases of camels under field conditions.

## **The Influence of Late Pregnancy and Excitement on Blood Parameters of Issa Type Dromedaries in Eastern Ethiopia**

*Getnet, A.M. and Abebe, W. 2002 Israel Journal of Veterinary Medicine. Vol\_60\_4*

The study was conducted in eastern Ethiopia, in and around Dire Dawa administrative council, in an attempt to see the influence of late pregnancy and excitement on blood values of Issa type dromedaries. Blood values were determined using standard hematological methods. An Improved Neubauer Haemocytometer was used to determine RBC and WBC counts. Sahli Helling's and Microhematocrit methods were used to determine Hb and PCV values respectively. Mean blood values found for camels at the stage of late pregnancy include: RBC-  $7.38 \pm 0.36$  mil/ $\mu$ l, PCV-  $26.46 \pm 1.02$  %, Hb-  $12.6 \pm 0.48$  g% and WBC-  $14.7 \pm 1.66 \times 10^3$ / $\mu$ l. RBC, PCV, Hb, and total WBC were higher as compared with not pregnant animals. An increase in the values of RBC-  $1.88$  mil/ $\mu$ l, total WBC-  $1.4 \times 10^3$ / $\mu$ l, PCV- 2.15 %, and Hb- 1 g% were seen for excited camels compared to those that were in the non-distabilized state. The Wintrobe indices of erythrocytes and the differential counts of leukocytes were also calculated and the influences due to these physiological phenomena are discussed. From this study it is noted that late pregnancy and excitement are found to affect the blood values, thus care has to be taken during the interpretation of blood values for disease diagnosis.

## **Survey of the village breeding program and evaluation of semen characteristics of camels in the Central Rift Valley of Ethiopia**

*Alemayew Gashaw. 2001. M.Sc. Thesis, Haramaya University, Dire Dawa, Ethiopia*

The study was carried out in Oromia and Afar National Regional States on camels owned by Afar and the Kereyu pastoralists with an objective to study the village breeding programs and to evaluate the semen characteristics of camels in the Central Rift Valley of Ethiopia. Camels in

the study area are kept traditionally in very extensive systems. The basic features of the production systems in the area consist of transhumance, nomadic, and sedentary. The survey-based study on village breeding program of camels was conducted at two districts using a total of fifty randomly selected pastoralist households. The overall village breeding program aims primarily at an increment of the milk, the fulfillment of the cultural interest, risk avoidance, getting replacement stock, getting extra animals for sale and bartering, and meat production. The breeding bull was found to be an important part of the herd. Though the study area shares almost identical traditional management practices and environmental conditions differing only in ethnicity, the statistical analysis showed the presence of a statistically significant difference ( $P < 0.01$ ) with age at puberty and sexual maturity. Age at puberty and sexual maturity were found to be  $4.0 \pm 0.112$  and  $4.5 \pm 0.116$  year for Afars, while it was  $3.5 \pm 0.123$  and  $4.97 \pm 0.095$  years for camels of Kereyus, respectively. The average service per conception for both districts was 1.75, while the average number of copulation per bull per day was 7.5. Among the criteria for bull selection, the most important was found to be the bearing of more female offspring. Give the limitation of getting more bulls, the assessment of semen characteristics of camels was conducted using three bulls. The three bulls with the age of 5, 6, 5, and 8 years were obtained from the FARM African Pastoral Project. Totally fifteen ejaculates, five from each bull were collected for ejaculation. Semen was collected using a bovine artificial vagina of 40 cm length. The semen was translucent in appearance, odorless, milky-white in color with least square mean, and a standard error value of  $8.7 \pm 0.20$  for pH and an ejaculate volume of  $3.6 \pm 0.23$  ml. The spermatozoa had a mean length of  $48.53 \pm 0.27$   $\mu\text{m}$ . The least-square mean values and standard error for mass activity and motility were observed to be  $1.93 \pm 0.18$  and  $51.67 \pm 1.26\%$ , respectively. The morphological abnormalities observed include head defects (double and detached) and tail defects (double tails coiled and bent tail), and its least square mean value obtained was  $13.07 \pm 0.28$  %. The mean sperm concentration and total sperm count was found to be  $8.47 \times 10^6$  /ml and  $30.89 \times 10^6$  / ejaculate, respectively. Total count and concentration showed statistically significant difference ( $P < 0.01$ ) among individual bulls whereas only concentration found to differ significantly ( $P < 0.01$ ) among the frequency of collections while all other characteristics did not. Among the identified existing management problems inbreeding was expected to be important, which could be minimized by the exchange of breeding bulls between ethnic groups, clans, and sub-clans accompanied with controlled breeding.

## **Morphological Diversities and Eco-Geographical Structuring of Ethiopian Camel (*Camelus dromedarius*) Populations. Emirates**

*Yosef, T., Kefelegn, K.; Mohammed, Y. K.; Mengistu, U., Solomon, A., Tadelle, D. and Han, J. 2014. Journal of Food & Agriculture (EJFA); 2014, Vol. 26 (4): pp. 371-389.*

The objectives of this study were to identify and characterize indigenous camel ecotypes and to assess phenotypic diversity and the relationship of camel populations in Ethiopia. A total of 494 heads of camels were investigated for phenotypic characterization. The study involved Jigjiga, Liben, Gelleb, Hoor, and Shinille from Somali as well as Amibara and Mille camel populations from Afar national regional states, which are the major camel rearing areas. The results showed that the average barrel and heart girths of the Liben camel population were significantly ( $p < 0.05$ ) larger than the remaining camel populations. Gelleb camels were significantly ( $p < 0.05$ ) superior for morphological variables particularly height at shoulder, chest depth, chest width, and hip-width to other camel populations examined. Females of the Amibara camel population recorded significantly ( $p < 0.05$ ) lower values for traits mentioned above as compared to other camel populations. The greatest morphological divergence was observed between Mille and Shinille followed by the difference between Amibara and Shinille camel populations. The least morphological divergence was detected between Hoor and Gelleb followed by that

between Amibara and Mille camels in aggregate gender. The quantitative and qualitative study indicated that Jigjiga and Hoor camel populations are milk type whereas Liben and Gelleb camel populations are meat type. The principal component analysis showed that body height traits and body height together with body shape traits explained most of the shared variability in female and male camel populations, respectively. The canonical analysis identified two canonical variables to be significant ( $p < 0.0001$ ) and sufficient to classify all camels studied. Combined differences among all morphological variables categorized these seven Ethiopian camel populations into five major camel groups. Therefore the findings from this study can be used for the description of body conformation, characterization, improvement, and conservation of various camel populations in the country.

# Part IV

## Feeds and Nutrition



Photo credit: Sisav Tilahun







## **The Browsing Dromedary Camel: Behavior, Plant Preference, and Quality of Forage Selected**

*Moges Dereje and Peter Udén 2005 Animal Feed Science Technology, 121: 297-308*

A study was conducted in the Erer valley, Eastern Ethiopia to determine the behavior, dietary preference, and forage quality of free-ranging dromedary camels. Each day for 24 days each in the dry and wet seasons, one camel was randomly selected from one of four age and sex categories (adult males (AM), young males (YM), young females (YF) and adult females (AF)), to measure time spent on various activities. The observation period was between the time of turning out for browsing and coming back to corrals at dusk. Browsing/grazing was the dominant daytime activity occupying between 0.63 and 0.68 of the time in both seasons, followed by walking, resting other activities, and ruminating. Young camels spent more ( $P < 0.01$ ) time browsing than adults. The adult camels spent more ( $< 0.05$ ) time resting and on other activities, as compared to the young camels in the wet season. The variation between seasons was also high and more ( $P < 0.001$ ) time was devoted to browsing in the dry season. In contrast, walking, ruminating and other activities were higher ( $P < 0.001$ ) in the wet season. Browsing preference observations were made on 240 camels to measure the time spent feeding on different plants. Each camel was followed for a maximum of 3 min in both the dry and the wet season. The camels selected a total of 21 species of plants in the dry and 30 in the wet season. On average, 0.79 and 0.83 of the camels' diet were comprised of perennial woody plants in the dry and wet season, respectively, and the 10 most preferred plant species occupied 0.87 and 0.80 of the total feeding time in the dry and the wet season, respectively. The highest-ranked plant was *Opuntia* (0.18) in the dry season and *Acacia brevispica* (0.22) in the wet season. The range in composition of the ten most preferred species (g/kg dry matter (DM)) was for crude protein (CP) 88–228, P 1.3–3.3, Ca 12–48, soluble tannins 29–216 and condensed tannins 9.4–129 abs. unit/g. In vitro, dry matter digestibility (IVDMD) varied between 0.41 and 0.65.

## **Preferably Browsed Forage Species by Camels (*Camelus dromedarius*) and their Mineral Contents in Jigjiga District, Eastern Ethiopia**

*Temesghen Desalgn and Y.K. Mohammed. 2012. Livestock Research and rural Development (LRRD), 24 (3): 2012*

The objectives of the study were to assess preferably browsed forage species of camels and their critical mineral contents. Data regarding feed resources were collected from 80 households using structured and semi-structured questionnaires, and visual observations. Following the survey, samples of dominant and preferably browsed forage species were collected to determine chemical composition. The mean concentration of macroelements (%) Ca (1.91, 1.26); Mg (0.48, 0.32); K (2.03, 1.46); and microelements (ppm) Fe (340, 97.6); Zn (73.6, 56.7); Mn (163, 82.9) and Cu (19.4, 12.2) in the sampled forages was higher than the lower recommended levels of these elements for camels in both the wet and the dry seasons, respectively. The mean concentration of Na (0.12, 0.09) and P (0.12, 0.04) were lower than the recommended level for camels in both the wet and the dry seasons. The effect of seasons was found significant for Ca, Mg, P, Fe, Mn Zn, and Cu with higher concentrations in the wet season. It is concluded that the camels in the study area could get an adequate amount of the mineral elements: Ca, Mg, K, Fe, Mn, Zn, and Cu from browses except for P and Na. There is a need for P and Na supplementation to the camels in the study district from other sources.

## **Forage Preference of Camel's calves (*Camelus dromedarius*) in Eastern Ethiopia**

Chibsa, M.B., Mummmed, Y.Y., Mohamed.Y.K., Leta, M.U., Hassen, A. and Gemeda, B.S. 2013. *J.Anim.Plant.Sci.* 23 (5):2013, pp.1236-1241.

A study on forage preference of camel calves from 6 to 12 months of age was conducted in eastern Ethiopia. Data were collected at an interval of 50 minutes for each calf for 15 consecutive days in dry and wet seasons. Based on the observation, calves commonly selected 13 plant species in the wet season. The top 10 plant species preferred by calves accounted for about 99% and 94% of the total browsed forage species during the dry and wet season, respectively. *Opuntia ficus-indicus* was the most frequently browsed forage species both in the wet (37%) and dry (41%) seasons. The second frequently browsed species in the dry season were *Lantana camara* (15.09%) and *Becium* species (15.09%) and in wet season *Becium* species (13.08%). The crude protein (CP) content of mixed plant species browsed by the calves in the dry and wet season was 13.8 and 27.7%, respectively. On average calves spent the dry and wet season spent  $79.51 \pm 14.83\%$  of their time on browsing during the dry and wet season in the present study. Relatively, more time spent on browsing in the wet season ( $82.11 \pm 9.74\%$ ) compared to the dry season ( $76.91 \pm 19.92\%$ ). From the study, it was concluded that the number of commonly preferred forage species of calves was less than the number reported for mature camels. Calves selected forage with lower CP content in the dry season compared to the wet season.

## **The Effect of Protein and Energy Concentrate Supplementation on Milk Yield in Dromedary Camels**

Moges Dereje and Arega Peter Udén 2003. In: *Proceeding of 10<sup>th</sup> annual conference Ethiopian Society of Animal Production (ESAP)*, 21-23 August 2003, Addis Ababa, Ethiopia. pp.319-326.

An experiment was conducted on-farm in Erer Valley village, Eastern Ethiopia to study the effect of supplementing with a protein or energy concentrate on milk yield in lactating dromedary camels. The treatments were controlled: browsing only during daytime, energy supplement (ES): natural browsing + ground maize (*Zea mays*), and a protein supplement (PS): natural browsing + decorticated groundnut (*Arachis hypogaea L.*) cake. Six dromedary camels were allocated randomly at peak lactation to three treatments in a double 3 x 3 Latin Square design. The animals were fed 4 kg of each supplement divided into two equal meals before and after daytime browsing for a period of 63 days in both the dry and wet seasons. Milk yield differences between all treatments were significant ( $P < 0.001$ ) with  $PS > ES > Control$ . The levels were 12.9, 9.1, and 7.6 Kg for PS, ES, and control, respectively. There were also significant differences ( $P < 0.05$ ) between the treatments with regard to butterfat with  $PS > Control > ES$  showing levels 3.9, 3.74, and 3.71% for ES, Control, and PS, respectively. Variation within seasons among the treatments followed the same trend for milk yield. Milk yield and butterfat differences between seasons were also significant ( $P < 0.001$ ) and ( $P < 0.05$ ) in which 9.2 and 10.4 kg milk and 3.7 and 3.8% butterfat were recorded for the dry season and wet season respectively. There was no significant difference between treatments and seasons with regard to protein. The results suggest that oilseed by-products supplements with relatively high CP value such as groundnut cake have a substantial effect on milk production of camels where the traditional range feed resources are already becoming scarcer.

## **Critical Macro and Micro Minerals Concentration in the Blood Serum of Camel (*Camelus dromedarius*) in Jigjiga District, Eastern Ethiopia**

*Temesgen Desalegn, Mohammed Y. K. and Beneberu Shimelis. 2012. J. Livestock Research for Rural Development (LRRD), 24 (4):2012*

For the study, 20 male camels aging from 5 to 9 years were used for blood sample collection. The blood samples were collected using 10ml plain vacutainer tubes by puncturing the jugular vein of each camel in two different seasons. T-test was employed to see the effect of seasons on the concentration of the minerals in the serum. The mean concentration (mEq/L) of macro minerals in the wet and the dry season were: Ca (5.91, 4.79); Mg (2.29, 1.14); Na (192, 170) and K (4.79, 5.6) ) and the mean concentration ( $\mu\text{g}/\text{dl}$ ) of micro minerals in the wet and the dry season were: Fe (76, 80); Zn (113, 92.8); Cu (75, 61.6) and Mn (30, 20) ), respectively. The effect of season was significant for Mg ( $P<0.001$ ) and Na ( $P<0.05$ ) with a high concentration in the wet season and K ( $P<0.05$ ) in the dry season. In this study, the mean concentration of P in the wet and the dry season (mg/dl) (1.38, 1.08) was very low compared to values reported in other studies. The lower concentration of P in the serum of camels could be attributed to the deficiency of P in the forages and indigenous supplements of mineral salts in the study district. So there is a need for P supplementation to the camels in the study district.

## **Physical properties and critical mineral concentration of mineral waters commonly consumed by camels (*Camelus dromedarius*) in Jigjiga District, Eastern Ethiopia**

*Temesgen Desalegn and Mohammed Y. K. 2012. Livestock Research for Rural Development (LRRD), 24(3):2012*

The study was carried out in the Somali National Regional State in Jigjiga District. The objective of the study was to assess some critical mineral elements in the mineral waters commonly consumed by camels in both the wet and the dry seasons. In the study district two places, *Biya'ada* and *Golajo'o* are commonly known as the sources of mineral water for camels. The mineral water samples were collected from both locations in both the wet and the dry seasons for analysis of both physical and chemical properties. The mean concentration of macro and trace elements (ppm) in *Biya'ada* and *Golajo'o* were Ca (127, 74.4); Mg (10.3, 7.29); K (27.6, 0.93); Na (197, 106); P (0.04, 0.03); Fe (0.78, 0.68); Mn (1.33, 0.44); Zn (0.32, 0.30) and Cu (0.25, 0.23), respectively. The high concentration of Ca ( $P<0.01$ ), K ( $P<0.05$ ), Na ( $P<0.01$ ), and Mn ( $P<0.001$ ) was observed in *Biya'ada* mineral water. Magnesium concentration was significantly higher ( $P<0.01$ ) in the wet season in the mineral waters. The interaction effect between seasons and locations was not significant. The mineral waters of *Golajo'o* and *Biya'ada* can contribute to the daily macro minerals requirements of 410kg (1.6 TLU) camel by about 8.6 to 15% Ca, 1.3 to 1.8% Mg, 20.1 to 38.3% Na, 1.2 -1.6 to  $<0.001\%$  K and  $<0.0001\%$  P in both locations, while their contributions of trace minerals are 7.87 to 9.03% Fe, 6.12 to 18.5% Mn, 2.09 to 2.22% Zn and 8.0 to 8.7% Cu, respectively.

## **Indigenous sources of minerals and mineral supplementation practices of pastoralists to camels in Jigjiga district, Eastern Ethiopia**

*Temesgen, D. and Mohammed, Y. K. 2012.  
Africa Journal Animal Biomedicine Science, 7(1): 65-70(2012)*

The study was carried out to document indigenous knowledge and practices of pastoralists on mineral supplementation to camels in Jigjiga district, eastern Ethiopia. For the study, a total of 80 respondents were selected from four camel producing rural kebeles in the district. The result indicated that mineral soil and mineral water are the common indigenous sources of mineral supplements to the camels in addition to commercial salt. Pastoralists took their camels to the indigenous mineral sources either to lick mineral soil and/or drink mineral water regularly. Table salt and mineral soil are the most important sources during the wet season and in the dry season, most pastoralists prefer mineral water for their camels. Even though pastoralists are knowledgeable about the importance of mineral supplementation and its benefits to their camels, most pastoralists supplement minerals to their camels every month. They preferred monthly supplementation because feeding and/or drinking mineral supplements was a laborious task as the indigenous mineral sources were far and inaccessible to the camels. Hence, emphasis should be put on improving indigenous mineral sources and mineral supplementation practices should be done based on the requirements of camels for each mineral element.

## **Physical properties and critical mineral concentration of mineral soils licked by camels (*Camelus dromedarius*) in Jigjiga District, Eastern Ethiopia**

*Temesgen, D.I, Mohammed, Y.K. and Melaku S.2011.  
Africa Journal Animal Biomedicine Science, 6 (1): 1-8 (2011)*

The pH of the soil samples ranged from 7.4 to 7.63 in the wet season with a mean of  $7.52 \pm 0.18$  and 8.01 to 8.16 in the dry season with the mean of  $8.08 \pm 0.18$ . The seasonal or locational difference was not significant for pH values. The mineral soils in both locations are sandy loam in texture and colors of the soils varied from dark brown to light brown in Biya'ada and Golajo'o, respectively. The soils from both locations predominantly contain high percentages of sand compared with clay and silt percentage. Organic matter (%) of the mineral soils ranged from 1.54 to 2.02 in the wet season with a mean of  $1.81 \pm 0.17$  and 0.56 to 2.06 in the dry season with a mean of  $1.12 \pm 0.17$ . Calcium concentration (%) in mineral soils ranged from 0.004 to 0.14 with a mean of  $0.04 \pm 0.016$  in the dry season and 0.18 to 0.31 with a mean of  $0.24 \pm 0.016$  in the wet season. The concentration of Mg (%) in mineral soils ranged from 0.01 to 0.15 with a mean of  $0.04 \pm 0.01$  in the dry season, and 0.15 to 0.21 with a mean of  $0.18 \pm 0.01$  in the wet season. The concentration of K (%) in mineral soils ranged from 0.001 to 0.01 with a mean of  $0.004 \pm 0.01$  in the dry season and from 0.01 to 0.04 with a mean of  $0.025 \pm 0.01$  the wet season. Sodium concentration (%) in mineral soils ranged from 0.09 to 0.15 with a mean of  $0.12 \pm 0.08$  in the dry season and 0.81 to 3.86 with a mean of  $2.18 \pm 0.08$  the wet season. Phosphorus concentration in mineral soils (ppm) ranged from 1.50 to 6.84 with a mean of  $4.83 \pm 0.84$  in the wet season and 4.14 to 11.89 with a mean of  $7.46 \pm 0.84$  in the dry season. The concentration of Fe in mineral soils ranged (ppm) from 24.47 to 86.13 with a mean of  $60.78 \pm 7.86$  in the wet season and 11.76 to 74.14 with a mean of  $28.17 \pm 7.86$  in the dry season. The concentration of Mn in mineral soils ranged (ppm) from 22.63 to 48.95 with a mean of  $34.68 \pm 5.67$  in the dry season and 41.31 to 126.56 with a mean of  $91.00 \pm 5.67$  in the wet season. Concentration of Zn in mineral soils ranged (ppm) from 0.01 to 4.64 with a mean of  $1.52 \pm 0.01$

in the wet season and 14.21 to 49.76 with a mean of  $29.44 \pm 0.01$  in the dry season. The concentration of Cu in mineral soils ranged (ppm) from 0.82 to 4.42 with a mean of  $2.09 \pm 1.17$  in the wet season and 4.21 to 13.02 with a mean of  $8.02 \pm 1.17$  and the dry season. The high concentration of Ca ( $P < 0.001$ ), Mg ( $P < 0.001$ ), K ( $P < 0.01$ ), Na ( $P < 0.001$ ), Mn ( $P < 0.001$ ) and Fe ( $P < 0.05$ ) was observed in the wet season and low concentration of Zn ( $P < 0.01$ ) and Cu ( $P < 0.01$ ) was observed in the wet season in the mineral soils. The interaction effect between seasons and locations was not significant except for Na, Ca, and Fe. Mineral soils of both locations in both seasons could not fulfill the requirement of camels for Ca, Mg, K, P, Zn, and Cu. However, the mineral soils of both locations could be used as supplements for Na, Mn, and Fe in the wet season only.



# Part V

# Health



Photo credit: Sisav Tilahun







## **Seroprevalence and participatory epidemiology of camelpox in the Afar region of Ethiopia**

*Weldegebrial G. Aregawi, Getahun E. Agga, Jemal Gishe, Reta D. Abdi, Preventive Veterinary Medicine, 161 (2018) 25–32*

Camelpox is endemic in most camel rearing regions of the world, causing significant economic losses. However, its epidemiology is not extensively investigated. We conducted a cross-sectional seroprevalence study of camelpox in Amibara and Awash Fentale districts in the Afar region of Ethiopia from November 2014 to May 2015. In addition, participatory epidemiology (PE) was conducted to identify the seasonal occurrence of the disease in the study districts. Blood samples were collected from 384 dromedary camels from 31 herds distributed in five pastoral associations (PAs) in the two districts. Serum samples were separated from the blood samples and tested for the presence of viral antibodies using a virus neutralization test. Seroprevalence data were analyzed using multilevel mixed-effects logistic regression models accounting for the 4-level hierarchical data structure (camels nested in herds-herds in PA, and PA in district). For the participatory data, Kendall's coefficient of concordance was used to assess agreements between the informants in identifying seasonal occurrences of the top five camel diseases. Camelpox antibodies were detected in 19.3% of camels ( $n = 384$ ), 81% of herds ( $n = 31$ ), and in all five PAs from the two districts in the Gabi Rasu zone of Afar region, Ethiopia. The seroprevalence did not significantly vary between herds, PAs, or districts suggesting the widespread occurrence of the disease. The estimated age-stratified basic reproduction number ( $R_0$ ) was 1.25 (95% CI: 0.62–2.19). Camelpox was identified as one of the top five common camel diseases in the area. The widespread occurrence of the disease can be attributed mainly to the commingling of camels from many herds during seasonal migration in search of feed and water, a practice very common under pastoral production systems. Although the PE informants indicated the clinical disease to be more common in young animals, seropositivity was higher in older animals. Camelpox commonly occurs during the minor and major rainy seasons. In conclusion, camelpox is found to be endemic in Afar pastoral region with sporadic outbreaks occurring during rainy seasons. Vaccination and improved camel management practices particularly during the high-risk period can be viable strategies to reduce the burden of the disease.

## **Parasitological and serological study of camel trypanosomosis (surra) and associated risk factors in Gabi Rasu Zone, Afar, Ethiopia**

*Weldegebrial G. Aregawi, Samson T. Kassa, Kidanie D. Tarekegn, Woldegebriel T. Brehanu, Sisay T. Haile and Fikre Z. Kiflewahid, J. Vet. Med. Anim. Health. Vol. 7(6), pp. 234-240, June 2015, DOI: 10.5897/JVMAH2015.0374*

Camel trypanosomosis (surra), caused by *Trypanosoma evansi*, is the most important single cause of morbidity and mortality in camels. Thus, a cross-sectional study was conducted from February to June 2012 to investigate the parasitological and serological prevalence and associated risk factors of camel trypanosomosis in two camel rearing districts of Gabi Rasu zone, Afar region, Ethiopia. A total of 408 randomly selected camels reared under extensive husbandry management systems were sampled for this study. The parasitological and serological examination was carried out by using hematocrit centrifugation technique (HCT) also known as Woo's technique and card agglutination test for trypanosomes (CATT/*T. evansi*), respectively. The overall parasitological and serological prevalence of camel trypanosomosis

was found to be 5.15 and 23.77%, respectively. Nine out of twenty-one camels that scored positive by the hematocrit centrifugation technique (HCT) test were negative by card agglutination test for trypanosomes (CATT/*T. evansi*), and the relative sensitivity of CATT/*T. evansi* test was found to be 57.14% (12/21). The mean packed cell volume (PCV) of parasitologically negative camels ( $24.27 \pm 0.18$ ) was significantly higher ( $p < 0.05$ ) than that of parasitologically positive camels ( $20.71 \pm 0.58$ ). Serologically negative camels had a mean PCV of (24.27%) which was not significantly different from that of positive camels (23.48%). Risk factors associated with parasitological and serological prevalence were found to be “study district” and “age”. Accordingly, camels in Awash Fentale district had significantly higher ( $p < 0.05$ ) parasitological and serological prevalence of camel trypanosomosis than in Amibara district. Generally, surra was found to be prevalent in the Awash Fentale district during the study period. Therefore detailed studies should be carried out on the seasonality of the disease and its vectors in order to establish the clear epidemiology of the disease.

### **Prevalence and Risk Factor of Brucellosis in Dromedaries in Selected Pastoral Districts of Afar, Northeastern Ethiopia**

*FikreZeru, WeldegebrialGebrezgabher, KidanieDessaiegn, Sisay Tilahun, YimerGuben, Hussen Mohammed and AngesomHadushcc, Journal of Natural Sciences Research, Vol.6, No.1, 2016*

A cross-sectional study was conducted on 813 camels from 63 herds in selected Afar pastoral areas from May 2012 to February 2013 to determine the prevalence and risk factors associated with camel brucellosis. A serum sample was collected and screened for brucellosis using the Rose Bengal Plate Test followed by the Complement Fixation Test of positive samples for confirmation. The herd-level seroprevalence was 17.46% and varied significantly among different herd sizes ( $\chi^2=8.84$ ;  $P<0.05$ ) and contact with small ruminants ( $\chi^2=3.91$ ;  $P<0.05$ ). Camel herds in contact with small ruminants were 6.64 times (OR=6.64; 95% CI: 1.30-33.88) more at risk for brucellosis infection than those herds which had no contact with small ruminants. Animal level seroprevalence was 2.09% and varied significantly among different herd sizes ( $\chi^2=8.079$ ;  $P= 0.018$ ). The prevalence of brucellosis was significantly higher in camels with a history of abortion (6.67%) ( $\chi^2=10.534$ ;  $P= 0.032$ ). Sex, age, body condition, physiological status, and parity were insignificantly associated ( $P>0.05$ ) with the prevalence of brucellosis. The present study suggests that *Brucella* infection is the likely cause of abortion in camel and small ruminants were the probable source of *Brucella* infection for camels in the study. On the other hand, based on the observation of the author, none of the camel herdsmen knew the disease and the prevailing habit of consumption of raw camel milk and the man-animal close contact in Afar pastoral are demonstrate the potential role of brucellosis as a zoonosis in the area. Therefore, improving management practices, public awareness, economic and zoonotic importance of the disease can assist disease prevention.

### **A study on the Productivity and Disease of Camels in Eastern Ethiopia**

*Tefera Melaku and Fesha Gebreab. 2001.  
Trop. Anim. Hlth. and Prod.33 (2001) 265-274*

A study concerning the performance trait of the Ethiopian indicated that in the camel herds examined, there were one active bull camels for 25 females. The bull camel was 5 years old at puberty; it reached rutting vigor at the age of 9 years, the number of mountings per day was 8 during the breeding season, and the reproduction span was 10 years. The female camel reached puberty at 4 years of age; the age at first calving was 5 years, and the lactation period was one year; the calving interval was 2 years; the calving rate was 50%, and the reproduction span was

10-15 years. The survival rate of the newborn calves was 50%. The average milk yield was 2.5 liters per day; the price of camel's milk was higher than that of cow's milk at US £ 0.5. Adult camels weighed around 500 kg; the dressing-out percentage was 52%. Mutton was preferred to camel meat, which came second in popularity, costing US £ 2/kg. Owing to their poor reproductive performance, camels are not efficient for producing meat. The camels worked for 16 hours per day covering 60 km. Animals' health problems encountered were trypanosomiasis, camelpox, camel pustular dermatitis, camel cephalopssis, dermatomycosis, mange mite, tick infestation, and balantidiosis, most of which mainly affected the young animals.

### **Effect of Season on the Productivity of camels (*Camelus dromedarius*) and the Prevalence of their Major Parasites in Eastern Ethiopia**

*Zelege, M. and Bekele, T. 2001. Trop. Anim. Hlth. and Prod. 33: 321-329.*

The productivity and the prevalence rates of the major parasites of camel (*Camelus dromedarius*) kept under traditional management conditions at Errer Valley, Ethiopia, were assessed for a year (October 1997- September 1998). The daily milk offtake was significantly higher ( $P < 0.05$ ) during the wet season ( $3.12 \pm 0.3L$ ) than during the dry season ( $1.49 \pm 0.04L$ ). Likewise, significantly higher ( $P < 0.05$ ) daily weight gains ( $50.68 \pm 0.54$ ) were observed during the wet season than during dry season ( $41.96 \pm 0.54$ ) in immature camels aged 1- 4 years. Most of the mating (84.85%) and calving (86.36%) of the camels occurred during the rainy months of the year. The annual calving percentage, number of services per conception, open days, and abortion rates for the camel herd was 42.7%, 1.4%, 162.8 days, and 12.1%, respectively. Trypanosomaevansi, Sarcoptesscabiei and strongyle parasites were present throughout the year, but their prevalence rates were higher during the rainy months than during the dry months. The minimum and maximum point prevalence rates for T.evansi were 5.4% and 20.6%, respectively. Similarly, the point prevalence rates for S. scabiei also varied from 4.7% during the dry season to 21.7% during the rainy months. The highest strongly eggs counts per gram of faeces and highest prevalence rate (85.7%) were observed in October, a rainy month whereas the lowest number of eggs per gram of faeces and the lowest point prevalence rates (61.5%) were recorded in April, a dry month. The highest fecal egg counts and Point prevalence rate of strongly-typed infection in the camel will have resulted from the favorable weather conditions (moisture and temperature) which are essential for the survival and development of the infective larvae on the pasture and which only occur during the rainy season.

### **Preliminary Observation on Camel Types and Major Parasitic Disease of Camel in Eastern Lowlands of Ethiopia**

*Bekele Tafese and Tezera Getahun. 1998. In: Proc. of 6<sup>th</sup> Annual Conference Ethiopian Society of Animal Production (ESAP), 14-15 May 1998. Addis Ababa, Ethiopia. pp. 201-207*

In these preliminary study two major types of camel, the Arrong and Ayyon were observed in the eastern lowlands of Ethiopia. The Ayyon type can be further divided into three subtypes: the Adden, Assen, and Dume ade. The Arrong is large and relatively good for milk and meat production; whereas the Ayyon is smaller, good for transport, and relatively drought resistant. The major parasitic disease problems identified were Trypanosoma evansi (95.1%), Cephalopsis titilater (86.4%), and ticks. The dominant ticks were Rhipicephlus pullchellus (49.38%), Amblyomma gemma (22.33%), and Hyalomma dromedarrii (8.41%). The current preliminary survey has

elucidated the important pathogenic parasite of the dromedary in the eastern lowlands. A detailed study on camel types and the parasitic disease of the camel is highly recommended to improve camel production and productivity in the area.

### **Traditional Husbandry Practices and Major Health problems of Camels in the Ogaden, Eastern Ethiopia**

*Abebe Wosene. 1991. Journal of Nomadic Peoples. 29: 1991, pp. 21-30*

An attempt was made to study the husbandry practices and major diseases of Ogaden camels during a period of six months from December 1987 to May 1998. A sample of animals was weighed and their reproduction was studied. To find out the pathological picture, a blood examination of 321 camels was made with revealed the presence of *Trypanosoma evansi* in 21 cases. Fecal examination of 180 showed a prevalence rate of 95.6% for the presence of eggs or oocyst of parasites. Post mortem examination of 41 camels in Jigjiga abattoir, in its turn, showed infestation rates of 29.2% hydrated cysts, 85.3% larvae of *Cephalopsis titillator*, 88% *Haemonchus Spp*, 39% *Stilsia Spp*, 44% *Avitellina Spp*, 31% *Monezia Spp*, and 4.8% *Thysaneizia giavdi*. Furthermore, diseases like Corynebacteriosis, skin necrosis camelpox and saddle sores were noted as important diseases of Ogaden camels. Therefore, based on these findings and the increasing realization of the role of the camel in arid and semi-arid lands, special attention on the epidemiological investigation and integrated approach in the control of camel disease is required to reach the maximum benefit of camel herding.

### **Camel Milk, Amoxicillin, and a Prayer: Medical Pluralism and Medical Humanitarian Aid in the Somali Region of Ethiopia**

*Lauren Carruth. 2014. Journal of Social Science Medicine*

This paper details how exposure to new clinics, diagnostic technologies, and pharmaceuticals during humanitarian relief operations in the Somali Region of Ethiopia shaped local pluralistic health systems and altered the ways in which residents subsequently conceived of and treated illness and disease. Despite rising demand for pharmaceuticals and diagnostic technologies among Somalis in Ethiopia, local Ethno physiologies continued to draw upon popular ideas about humoral flows, divine action, and spirit possession. Demands for therapeutic camel milk, Qur'anic spiritual healing, herbal remedies, and other historically popular therapies persisted but were shaped by concurrent demands for and understandings of diagnostic biotechnologies and pharmaceutical medications. The reverse was also true: contemporary understandings and uses of non-biomedical healing modalities among Somalis shaped evaluations of clinical care, including healthcare during humanitarian responses. To illustrate these phenomena, based on ethnographic research in eastern Ethiopia between 2007 and 2009, this paper explores three topics vital to Somalis' pluralistic healthcare systems: camel milk and the management of digestive bile; women's experiences and clinical presentations with pain and disorder in their reproductive systems; and the rising popularity of high-tech diagnostic tests. I conclude that medical humanitarian aid never happens in a vacuum or among truly treatment-naïve populations. Instead, aid unfolds within ever-changing and pluralistic health cultures, and it permanently alters and is altered by the frames within which people evaluate and make future decisions about healthcare.

## **Camel brucellosis and management practices in Jigjiga and Babile Districts, Eastern Ethiopia**

*Berhanu Tilahun, Merga Bekana, Kelay Belihu and Endrias Zewdu. 2012. J.Vet. Med. Anim. Health. 5 (3): 81-86.*

A cross-sectional study was carried out on sera of 822 randomly selected camels in order to estimate seroprevalence and risk factors of brucellosis and assess camel management practices. A questionnaire survey was administered to one-hundred willing respondents out of the total of 185 camel owners whose camels were included in the sample unit. The sera were first screened by the Rose Bengal plate test (RBPT) and then all positive reactors were further tested by the complement fixation test (CFT) for confirmation. The overall seroprevalence of brucella in camels was 2.43% (95% CI = 1.3 - 3.8). None of the potential risk factors studied (district, sex, age, herd size, camel rearing experience, and parity) had a significant effect on animal level seroprevalence ( $P > 0.05$ ). The herd-level seroprevalence was significantly associated with abortion ( $P = 0.012$ ) and stillbirth ( $P = 0.016$ ). A significant proportion (40%) of camel herders kept camels together with cattle, sheep, and goats. Thirty-two percent of camel herders kept camel with cattle. The camel herd composition was dominated by pregnant (21.8%), lactating (21.1%), and mature non-lactating she-camels (19.3%). The major diseases affecting camels were trypanosomiasis (93%), anthrax (80%), pneumonia (70%), “bent neck” (59%), abscess (59%), endoparasites (54%) and ectoparasites (51%). Camel management practices like herding, watering, milking, delivery, and mating assistance were mainly the responsibilities of adults and young males. Although seroprevalence of camel brucellosis was low, it could pose a considerable threat to public health and the market value of camels. The camel health and management practices are inadequate. Public education and detailed epidemiological studies of camel diseases were suggested.

## **An epidemiological study of major camel diseases in the Borana lowland, Southern Ethiopia**

*Bekele Megersa. 2010. Dryland Coordination Group Report No. 58*

This report describes the seasonal occurrences of major camel diseases along with participatory investigations of constraints and potentials of camel production in the Borana lowland areas. Much emphasis was given to the seasonal occurrences of major camel diseases, causes of calf morbidity, and mortality. Comparative indigenous knowledge of camel pastoralism between Gabra and Borana herders was also discussed. The study was also dealt with traditional management practices (herd movement, foraging, watering, salt supplementations, and breeding), health care, morbidity, and mortality in camel herds. The study was based on three seasonal field investigations conducted by the researcher and the other two or more veterinary staff (one veterinarian and one to two animal health assistants). It was carried out during the dry period (December 2007), major wet season (April to May 2008), and minor wet season (October to November 2008) with the financial support from Drylands Coordination Groups (DCG) Norway. Classical disease investigation methods; herd health investigation and clinical examinations of individual animals, sample collection and laboratory examination as well as participatory epidemiological study, questionnaire survey, secondary data, and literature review were carried out. In the result and discussion part, the research findings were illustrated with logical explanations and in-depth literature information. For this purpose, the findings of this research have been presented in a national workshop arranged for awareness creation, experience sharing, and drawing the attention of different stakeholder participants. Since little is

known about the health problem of Ethiopian camels, this research plays a magnificent role in filling the knowledge gap and drawing attention towards the improvement of health care and management practices with subsequent enhancement of production performances. This may substantially contribute to food security and human welfare particularly in vulnerable households of arid and semi-arid areas practicing camel pastoralism. This research work was conducted in the food insecure areas of the Borana region with the aim of improving the production performances through control of camel diseases. The research output may avail information and optimize the knowledge of camel diseases, which contributes to the improvement of health care. This leads to boost up milk production and increase income generation of pastoral households. Thus, this epidemiological camel disease investigation was conducted by combining the indigenous knowledge and modern scientific research approach. Accordingly, the application of participatory epidemiology supplements the conventional (scientific) epidemiological disease investigation approaches.

### **A study on major ectoparasites of a camel in and around Dire Dawa, Eastern Ethiopia**

*Dinka A., Eyerusalem B. and Yacob H.T. 2010. Revue Méd.Vét., 161 (11): 498-501.*

A cross-sectional epidemiological study was conducted from November 2007 to April 2008 in eastern Ethiopia at Dire Dawa town Vet clinic, municipal abattoir, and at six peasant associations to determine the prevalence and species composition of ectoparasites infecting camels and to identify those factors that could contribute to the occurrence of these parasites. Out of 384 heads of camels examined, 236 (61.46%) were found to harbor different species of ectoparasites. Even though a significant difference ( $P < 0.05$ ) in the prevalence of tick infestations was observed among different study sites, there was no difference observed between the two sexes and age groups. Likewise, significant variation was not observed in the prevalence of mite infestation among the study sites, sexes, and between the age groups. Three species of ticks namely *A.gemma*, *H.dromedarii*, and *R. pulchellus* were identified in this study. *R. pulchellus* (27.86%) was found to be the predominant species followed by *H. dromedary* (15.36%) and *A.gemma* (15.1%). Only one genus of mange mite (Sarcoptes) was identified during this study.

### **Microbiological Safety and [hygienic] Quality of Camel Carcasses and Meat in Jigjiga Town, Somali National Regional State, Ethiopia**

*Henok A, Amare Be., Berhanu S. and Biressaw. 2013. MSc. Thesis, College of Veterinary Medicine, Haramaya University, Ethiopia*

A cross-sectional study was conducted to assess microbiological safety and hygienic quality of camel carcasses and meats at the abattoir and retails in Jigjiga town, Somali National Regional State of Ethiopia. A total of 230 samples (70 camel carcasses, 70 meat, and 90 pooled environmental samples) were examined for the presence and load of *S. aureus*, *E. coli* O157:H7, *L. monocytogene*, aerobic bacteria, fecal coliform (FC), yeast and mold (Y&M) and campylobacter spp. According to interviews and observations, it was found that the municipal abattoir was not well organized. It was noted that the camel slaughter process is conducted simply on a slab. During the assessment, 84.61% of the butchers did not use protective clothing. Based on the microbiological survey, retail meat was identified to harbor a significantly higher number of *E.coli* than abattoir samples. Out of the 140 abattoir carcasses and retail meat samples collected and analyzed, 5 (3.57%) were positive for *Campylobacter* spp. Mean FC

and Y&M counts of camel carcasses from the abattoir ( $5.73\pm 0.066$  and  $4.64\pm 0.069$  log<sub>10</sub> cfug<sup>-1</sup>) were significantly lower as compared to retails meat ( $6.17\pm 0.067$  and  $4.95\pm 0.067$  log<sub>10</sub> cfug<sup>-1</sup>). With the exception of *L. monocytogene* (11cfug<sup>-1</sup>), all pathogen and indicator organisms examined were detected above permissible limits. According to this result, the further the process progress the greater the risk of contaminating the product. Abattoir and retails meat contact surfaces might have served as sources of contamination for the product. The current intervention strategies used in the abattoir and retails are insufficient in reducing the contamination of camel meat. Therefore, improved interventions should be introduced in order to enhance the overall safety and hygienic quality of camel meat and safeguard the consumer from foodborne pathogens.

## **Camel Sudden Death Syndrome: Outbreak of an Unknown Camel Disease in the Horn of Africa**

*Ilona Gluecks, VSF Suisse and Mario Younan. 2010. ELMT Technical Brief. pp. 1-7.*

An unusually high number of deaths were reported in camels starting in Ethiopia in 2005 followed by Somalia in 2006 and Kenya in 2007. Mainly adult camels were reported to be dropping dead without any prior symptoms. Following the reports various surveys were carried out, starting with a USAID funded investigation in Ethiopia followed by a UNOCHA funded project in Somalia<sup>2</sup> and a FAO supported investigation in Kenya<sup>3</sup>. The results of the investigation of eight post mortem cases in Ethiopia were inconclusive. Parasites such as *Haemonchus*, *Trypanosoma*, tapeworm, and roundworm were found as well as two suspected cases of clostridial enterotoxaemia, one case of diarrhoea and dehydration. However, in six cases histological examination revealed lymphocytic myocarditis. The researchers could not isolate any particular virus, but could not rule out the involvement of a viral agent. The following section describes the findings of two investigations carried out in Puntland by VSF Germany and in Northern Kenya by VSF Suisse in close collaboration with the Kenyan Department of Veterinary Services (DVS).

## **Husbandry Practices and Utilization of Camel Products in Borana Zone of Southern Oromia, Ethiopia**

*Dejene Takele Gebissa. 2015. Science Publishing Group; 3 (4): 191-197.*

This survey was conducted in Borana zone to assess camel husbandry and product utilization practices, and identify major constraints of camel production. The result showed that the camel was ranked the first economically important livestock species followed by goats and cattle, consecutively. Per producer holding of the female of 1-3 year, a heifer of 3-5 year, matured female of greater than 5 years, male of 5 years, male of less than 5 years and breeding bull greater than 5-year camel was 4.17, 2.50, 3.83, 1.83, 0.50 and 0.50, respectively. Selection of breeding bull and female camel and uncontrolled mating was common practices. Lactation length was 13.38 months while daily milking frequencies were 3.24 and 2.57 during the wet and dry season, respectively. Daily milk yield per camel was 8.4 and 4.75 liters for wet and dry seasons, respectively. A liter of camel milk cost 2.30 and 4 birr during the wet and dry season, respectively. Disease, poisonous plants, and low extension and health services were the main problems of camel production. Boosting the capacity of the community on improved husbandry practices and product utilization, and developing coordinated efforts for camel disease control and prevention schemes should be an assignment of all stakeholders.



## **Influence of Internal and External Parasites on Pre and Post Weaning Performance of Camel Calves (*Camelus dromedaries*) At Errer Valley, Eastern Ethiopia**

Mohamed Y K., Merga BC, and Yesihak Y M. 2013. *Intern. J. Res. Rev. Pharm. Appl. sci.* 3 (4)566-577

This experiment was conducted at Errer Valley, Harmacya University camel research herd, eastern Harrarghe zone from August 2008–June 2009. A total of 20 (9 female and 11 male) camel calves of 2 to 6 months of age were used for the study. The treatments were weaning at 6(T1), 8(T2), 10(T3), and 12(T4) months of age. T1, T2, and T3 were supplemented with concentrate consisting of a mixture of 60% wheat bran and 40% *Guzietia abyssinica*, nougseed cake (at 1.6 kg DM per 100 kg body weight) from the respective weaning age up to 12 months. The highest prevalence (83.33 %) and highest EPG (2908) of faeces were observed during the rainy season than during the dry season which was 59.26 % and 919, respectively. However, there was no significant ( $P > 0.05$ ) differences in prevalence and EPG of faeces among all treatment groups and calf sex. Mean packed cell volume (PCV) of camel calves in the study area was 21%. Examination of larvae count showed five types of gastro intestine intestinal parasites (GIP) in the study animals. The parasites identified were *Haemonchus* spp, *Trichostrongylus* spp, *Strongyloides* spp, *Nematodirus* spp, and *Trichuris* spp with a prevalence of 80%, 80%, 73.33%, 6.67%, 6.67%, and 6.67%, respectively. Relatively, the parasite infestation was higher in T3 (39.6%) and lower in T1 (14.67). Mange mite prevalence was the highest for supplemented camel calves in T1 (80%) followed by animals in T3 (60) and T2 (40) while it was the lowest for T4 (20%). In general, EPG count revealed that calves in all treatment groups were equally highly infested, but the effect of parasitic infestation was well manifested in those camel calves supplemented for a short period of time (T<sub>3</sub>) and those not supplemented (T<sub>4</sub>). 15% mortality observed in T<sub>3</sub> and T<sub>4</sub> might be the lack of resistance to disease parasites and malnutrition whereas those supplemented for more than 4 months might have developed resistance against parasite disease. It is thus recommended that pastoralists should be aware and oriented about the importance of supplementary feed to calves in order to save the life of animals since effective prophylactic drug and curative treatments may costly and not available to the pastoral.

## **Internal and external parasites of camels (*Camelus dromedarius*) slaughtered at Addis Ababa Abattoir, Ethiopia**

Aboma Regassa, Nesibu Awol, Birhanu Hadush, Yisehak Tsegaye and Teshale Sori. 2014. *J. Food. Agri. Sci.* 6 (7). DOI: 10.5897/JVMAH20140346

A cross-sectional study was undertaken to estimate the prevalence of internal and external parasites of camels slaughtered at Addis Ababa abattoir, Ethiopia. A total of 384 of camels originating from Borena and Metehara areas were examined during the study period and all (100%) of them were found to harbor at least two parasite species. In this study, the prevalence of tick, gastrointestinal parasites, *Cephalopinattillator*, Hydatid cyst, and *Sarcoptes scabiei* var. *camels* were 100, 95.6, 68.2, 65, and 35.4%, respectively. The gastrointestinal parasite's ova/oocyte identified include *Strongylus* species, *Trichuris* species, *Strongyloides* species, and coccidia at prevalence of 78.1, 47.1, 44.5 and 25.3%, respectively. Of the total 1347 pooled samples of tick collected from 40 randomly selected camels. *Rhipicephalus pulchelis*, *Rhipicephalus evertsi evertsi*, *Hyalomma dromedary*, *Amblyomma gemma*, *Amblyomma variegatum*, and *Boophilus decoloratus* were identified at a proportion of 53.90, 21.01, 13.66, 7.5, 3.19, and 0.74%, respectively. The average tick burden from half body region of camels was  $33.7 \pm 6.24$  (range 26 to 53). In general, this study indicates that parasites are still

the major problems hindering the productivity and health of camels, hence the implementation of strategic control measures and further studies are recommended to reduce the effect of parasites on camel health and productivity.

## **Major Animal Health Problems of Market Oriented Livestock Development in Alamata Woreda**

*Yohannes Tekle. 2007. DVM Thesis, Faculty of Veterinary Medicine, Addis Ababa University, Ethiopia.*

An attempt was made to study major health problems of livestock in Alamata *Woreda*, northern Ethiopia, from December 2006 to April 2007. The questionnaire survey was carried out on 100 livestock owners to collect information on the livestock production system and the major health problems recognized by farmers in the study area and cross-sectional study on 841 diseased animals which constitute 334 cattle, 185 sheep, 173 goats, 56 equines (donkeys and mules) and 93 camels were undertaken. During the cross-sectional study from the whole diseased animals which were presented to Alamata, Gargelle, and Tumga Veterinary clinics, 841 animals were selected randomly from each species and then they diagnosed base on history, general, and systemic examinations and laboratory tests to identify diseases (cases) that frequently affect animals in the study area during the study time. The questionnaire survey result revealed that in cattle infectious diseases (47%) is the most important health problem, followed by the miscellaneous case (27%) and parasitic problem (26%), in sheep parasitic problems (49%) followed by infectious diseases (27%) and miscellaneous cases (24%) are the common health constraints and similarly in goats, the most important health problems were those caused by parasites (42%) followed by infectious cases (38%) and miscellaneous diseases (20%). In equines (donkeys and mules) miscellaneous cases (63%) followed by parasitic diseases (22%) and infectious diseases (15%) were identified. While in the camel the predominant health problems were miscellaneous cases (68%) and parasitic diseases (32%), respectively. In poultry NCD (54%) was the most devastating infectious disease followed by parasites (41%) and predators (5%). Results of the cross-sectional study also indicated that septicemic pasteurellosis (19%) in small ruminants, tick challenge (14%) in all species and particularly cattle, traumatic injury/wound (11%) in all species and especially in cattle and camel, LSD (9%) in cattle were the leading cases which were diagnosed from December 2006 to April 2007. During the cross-sectional study, it is also pointed out that LSD and pasteurellosis in cattle and small ruminants, respectively occurred as an outbreak and resulted in the deaths of many animals. The study also addressed that the animal production system in the study area, in general, is traditional with a number of problems. Most of the respondents complained that animal feed followed by water shortage is a serious problem. They also indicated that during animal marketing disease transmission is a big problem.

## **Mysterious mortality in camels (*Camelus dromedarius*) in Borana, Ethiopia: Evidence of its Association with Reproductive Age Groups**

*Dawo F. 2010. Rev. sci. tech. Off. int. Epiz. 29 (3), 621-628.*

In May and June of 2007, sudden death was observed in camels in southern pastoral areas of Oromia, Ethiopia. It significantly ( $p < 0.001$ ) affected reproductive age groups of both male and female camels (in females and males, 63.9% and 10.8% of those in reproductive age groups were affected, respectively). Pregnant females (37.6%) were affected significantly more often ( $p < 0.001$ ) than non-pregnant females. Absence of rigor mortis and absence of blood clotting, together with the death of pregnant and lactating camels, were common findings during

different outbreaks, but no aetiological agent such as *Bacillus anthracis* was isolated. In addition to the loss of milk in lactating camels and loss of the calf in pregnant individuals, the average value of the dead camels was 2377.6 birr (~US\$264). A multifactorial cause of mortality is hypothesized. Hence, research to develop an intervention, with increased input of financial resources and time, is required urgently so that the cause of the problem can be discovered and the disease can be controlled.

### **Trypanosomosis in Camel (*Camelus dromedarius*) in Delo-Mena District, Bale Zone Oromia Region, Southwest Ethiopia**

*Basaznew Bogale, Ferew Kelemework and Mersha Chanie. 2012.  
Acta Parasitologica Globalis; 3 (1): 12-15.*

Across sectional study was carried to determine the prevalence of camel trypanosomiasis (surra) in Delo-Mena district, Bale Zone, Oromia region, southwestern Ethiopia from September to December 2004. Blood samples were collected from randomly selected 395 camels. Wet film and Giemsa-stained blood smears were used for the detection of trypanosomes. Among these, 72 (18.22%) samples were positive for *Trypanosoma evansi* (*T. evansi*), the only *Trypanosoma* species identified. A higher infection was found in males (20.25%) as compared to females (17.72%). However, there was no statistically significant difference in prevalence between sex categories ( $p > 0.05$ ). The highest 27.63% infection was noted in the age group  $> 4$  years, followed by 14.54 and 10.52% in 1 to 3 years and 3 to 4 years old camels, respectively. There was a statistically significant difference ( $p < 0.05$ ) in susceptibility among age groups. These results seem to indicate that *T. evansi* infection has a relatively low prevalence in the study area. There is a need for further study on the distribution and seasonality of the disease and its vectors to establish control measures in affected herds and avoid dissemination of the disease.

### **Prevalence, Economic and Public Health Significance of Camel Hydatidosis in Dire Dawa Municipal Abattoir, Eastern Ethiopia**

*Abdiselam Mohammed Hayer, Mersha Chanie Kebede, and Ismail Warsame. 2014.  
Acta Parasitologica Globalis; 5 (2): 98-106.*

The cross-sectional study was conducted from October 2013 to April 2014 at Dire Dawa municipal abattoir with the objectives of determining the prevalence of camel hydatidosis and to estimate the economic loss attributed to hydatid disease. Of the 450 examined animals 129 (28.67%) were found to harbour hydatid cysts. Age, sex, body condition, and origin of the animals were found statistically insignificant in variation. The total number of organs affected by one or more hydatid cyst(s) was found to be 162 out of which liver account for 83(51.23%), lung 73(45.06%), gastrointestinal tract 4(2.46%), kidney 1(0.6%) and heart 1 (0.6%). Liver infection was greater than in lung, followed by the gastrointestinal tract, kidney, and heart. Out of the examined cysts, 41.01% were found to be fertile and viable, while 17.94%, 21.15%, and 19.97% were non-viable, sterile, and calcified cysts, respectively. The fertility of the cysts was 68.75% and 70.5% in the liver and lungs, respectively. The annual financial loss at Dire Dawa municipal abattoir was estimated Ethiopian birr 27, 242.67. From the result obtained in this study, it can be concluded that hydatidosis is one of the most economically important camel diseases in the area warranting serious attention.

## **Prevalence of *Trypanosoma evansi* Infection in the One-Humped Camel (*Camelus dromedarius*) in Jigjiga Administrative Zone of the Ethiopian Somali Region**

*Eshetu Z., Desta B. and Amare L.B. 2013. Global Veterinaria; 10 (2): 233-238.*

A survey was conducted between November 2010 and April 2011 to update the prevalence of cameline trypanosomosis (surra) and to determine the influence of site, age and sex on *Trypanosoma evansi* infection in the one-humped camel (*Camelus dromedarius*) at Babile, Gursum and Jigjiga districts of Jigjiga administrative zone in the Ethiopian Somali region. Randomly selected 384 camels were blood-sampled and examined for *T. evansi* infection by wet film, Giemsa-stained thick/thin smears, and dark-ground buffy-coat technique (BCT). More than 6% (6.25%; 95% CI: 3.81-8.68%) of the camels had microscopic evidence of *T. evansi* infection. The disease was found in all three districts at significantly ( $X^2=8.422$ ;  $p=0.015$ ) varying rates: 2 Babile (11.02%; 95% CI:6.0-17.0%); Gursum (5.4%; 95% CI:1.0-9.0%); and Jigjiga (2.3%; 95% CI:0.0-5.0%). Prevalence was significantly ( $X^2=6.458$ ;  $p=0.011$ ) higher in adults (8.9%; 95% CI:5.0-13.0%) than young camels, 2 (2.5%; 95% CI:0.0-5.0%). The mean PCV was severely ( $P=0.000$ ) compromised in parasitaemic camels (25.06±0.814%). The study underscored camel surra as enzootic in the areas occurring at a 'presumed' lower prevalence than the "true prevalence" rate given the limited sensitivity of the methods used. Strategic trypanocidal interventions along with the use of more sensitive diagnostic tests are suggested as a feasible surra management strategy for the areas. Further research is also indicated to elucidate factors involved in the transmission dynamics of *T. evansi* including reservoir hosts that may modify the disease epidemiology.

## **Prevalence of Gastro-Intestinal Nematodes of Camel Slaughtered at Akaki Abattoir, Addis Ababa, Ethiopia**

*Tibebesilasse Birhanu, Ataf Alebie, Bulto Giro and Mersha Chanie. 2014. Acta Parasitologica Globalis; 5 (3): 177-182*

A cross-sectional study was conducted from November 2013 to April 2014 in Akaki Abattoir, Addis Ababa, Ethiopia to determine the prevalence of Gastrointestinal Nematodes based on the Coprological examination and to assess the effect of risk factors for Gastrointestinal Nematodes in Camels. The coprological examination was conducted using a flotation technique revealed out of a total of 384 fecal samples examined 213 were positive for Gastrointestinal Nematode with an overall prevalence of 55.5%. The most common Nematodes encountered were *Strongyle eggs* (48.7%) followed by *Trichuris* species (3.9%) and mixed infections (2.9%). Statistical analysis of host factors such as sex, age, and origin with the prevalence of Gastrointestinal Nematode infection indicated no significant association ( $P>0.05$ ), whereas there was a significant variation ( $P<0.05$ ) of Gastrointestinal Nematodes infections between different body condition of camels. The present study showed that the Gastrointestinal Nematodes are an important health problem that affects the well being and productivity of the camels. More emphasis should be given to integrated approaches of control of Gastrointestinal nematodes of the camel.

## **Prevalence of Camel Trypanosomosis at Selected Districts of Bale Zone Southern Ethiopia**

*Dereje Abera, Tadesse Birhanu and Tajudin Baker. 2014. Sci. Technol. Arts Res. J., 3(3): 103-106.*

A cross-sectional study was conducted from November 2013 to March 2014 at selected districts of Bale zone, the Oromia Regional States of Ethiopia to determine the prevalence of camel trypanosomosis and assess associated potential risk factors. A simple random sampling technique was used and the study animals were selected based on the camel population of the district in the study area. The wet, thin smear and the Buffy coat examination were employed under the microscope. Out of 392 examined animals, 70 (17.9%) were positive for *Trypanosoma evansi*. There was a statistically significant difference between age groups, districts of the animals, and trypanosome infection ( $P < 0.05$ ). A higher prevalence of the infection was recorded in Age group of  $>4$  years (27.6%) followed by 3 years (14.5%) and 3-4 years old camels (10.5%) respectively. However, there was no statistically significant difference observed between sex with the occurrence of the disease ( $P > 0.05$ ). The highest prevalence of the disease was observed in Delo-Mena district, 42 (23.9%) whereas the lowest was recorded in Goro district, 9 (9.90%) during the study period. The result of the current study revealed that camel trypanosomosis was highly prevalent in the study area. Thus, there is a need for further study on the distribution and seasonality of the disease and its vectors in order to establish effective prevention and control measures in the affected herd.

## **Prevalence of camel trypanosomosis and its vectors in Fentale district, South East Shoa Zone, Ethiopia**

*Tadesse Eguale, Tadesse Eguale, Hassen Chaka and Hassen Chaka. 2011. Vet. Arhiv 81 (5), 611-621*

A cross-sectional study was conducted to determine the prevalence of camel trypanosomosis and assess A cross-sectional study was conducted to determine the prevalence of camel trypanosomosis and assess the distribution and dynamics of the vectors responsible for the transmission of the disease in five localities of the distribution and dynamics of the vectors responsible for the transmission of the disease in five localities of Fentale district from September 2008 to January 2009. The parasitological examination was conducted using the Fentale district from September 2008 to January 2009. The parasitological examination was conducted using the microhaematocrit centrifugation technique (MHCT) and examination of Giemsa stained blood smears. The only microhaematocrit centrifugation technique (MHCT) and examination of Giemsa stained blood smears. The only species of trypanosome identified was species of trypanosome identified was *Trypanosoma evansi* with a prevalence of 4.7% by MHCT and 4.4% by with a prevalence of 4.7% by MHCT and 4.4% by blood smear. The prevalence was higher in males (6.8%) than female (4%) camels. With regard to age, calves blood smear. The prevalence was higher in males (6.8%) than female (4%) camels. With regard to age, calves (less than 2 years of age) were negative; the prevalence is high (7.7%) in young camels (between 3-4 years of (less than 2 years of age) were negative; the prevalence is high (7.7%) in young camels (between 3-4 years of age) and 4% in adult camels (older than 4 years of age). However, the difference between in prevalence sex age and 4% in adult camels (older than 4 years of age). However, the difference in prevalence between sex and age groups was not statistically significant ( $P > 0.05$ ). The prevalence using blood smears was found to be and age groups were not statistically significant ( $P > 0.05$ ). The prevalence using blood smears was found to be different between different localities; the highest being 7.8% for Kobo and the lowest 2%

for Haro kersa. The difference between different localities was the highest being 7.8% for Kobo and the lowest 2% for Haro kersa. The mean packed cell volume (PCV) of mean packed cell volume (PCV) of *Trypanosoma evansi* positive camels (22.43%) was significantly lower than that of negative camels (28.13%) ( $P < 0.05$ ). More than 99% of the biting flies captured from the study area were that of negative camels (28.13%) ( $P < 0.05$ ). More than 99% of the biting flies captured from the study area were flies under the genus *Stomoxys*, while a few others such *Tabanus*, *Chrysops*, and *Lyperosia* were also captured. The highest fly count was recorded in September whilst the lowest was recorded in December. The current findings should not be generalized for all camel producing areas of the country or all seasons in the same findings should not be generalized for all camel producing areas of the country or all seasons in the same area. The prevalence of *Trypanosoma evansi* might be higher during the rainy season when the fly population (*Tabanus*) is expected to be high. Therefore, detailed studies should be carried out involving different seasons and the relative importance of different vectors in the transmission of the disease in different ecologies. and the relative importance of different vectors in the transmission of the disease in different ecologies.

## **Review on Camel Trypanosomosis (surra) due to *Trypanosoma evansi*. Epidemiology and Host Response**

*Eyob E. and Matios L. 2013. J. Food. Agri. Sci. 5(12), 334-343.*

Trypanosomosis is the most important and serious pathogenic protozoal disease of camel caused by *Trypanosoma* species. *Trypanosoma evansi* parasite has a wide range of distribution throughout tropical and subtropical regions of the world. Mostly, camels suffer from trypanosomosis caused by *T. evansi* that is transmitted mechanically, non-cyclically, by hematophagous flies such as horseflies (*Tabanus*) and stable flies (*Stomoxys*) which are endemic in Africa, Asia, and South America, although in America the vampire bat also acts as a vector as well as reservoir hosts. The disease manifests itself in different forms: acute, sub-acute, chronic, and in-apparent. Anemia appears to be a major component of the pathology of surra and generally, the degree of anemia might be considered as an indicator of the disease severity. Control of camel trypanosomosis depends mainly on the use of curative and prophylactic drugs even though this strategy is faced with various problems. Surra has a wide host spectrum, the main host species varies with the geographical region. In Africa, beyond the northernmost limits of the tsetse fly belt, and in parts of East Africa, camels are the most important host, whilst in Central and South America the horse is principally affected. In Asia, a much wider range of hosts is involved, including cattle, buffalo and pigs. The disease is most severe in horses, donkeys, mules, camels, dogs, and cats. *T. evansi*, like other pathogenic trypanosomes, induces a generalized immune-suppression of both humoral antibody response and T cell-mediated immune responses. As a result, in the long term, the host's immune responses fail and it succumbs to either the overwhelming parasite load or to secondary infection, consequently leading to the occurrence of the trypanosome induced immunopathology. This paper reviews the epidemiology of the disease and host response against the parasite.

## **Sero-epidemiological Study of Camel Brucellosis in Mehoni District, South Eastern Tigray, Ethiopia**

*Habtamu Tassew Tarekegn. 2014. East Africa TIRI Research Brief*

Adapted to the arid climates of Ethiopia, camels serve as a vital domestic animal species for pastoralists, who rely on the animals for food security. However, infectious diseases such as brucellosis can have considerable impacts on both camel and human health. In an analysis of 450 blood samples collected from animals in the Mehoni district of northeastern Ethiopia, researchers determined the number of camels and goats that tested positive for brucellosis (i.e., seroprevalence) in the region and identified the potential risk factors associated with the occurrence of the disease. In addition, 100 randomly selected camel owners were interviewed to determine local knowledge about zoonotic diseases and what resources and education are needed for prevention.

## **Sero-epidemiology of camel brucellosis in the Afar region of Northeast Ethiopia**

*Angesom Hadush, Mahendra Pal, Tesfu Kassa and Fikre Zeru. 2013. J. Vet. Med. Anim. Health. 5(9), 269-275.*

Camel brucellosis represents a major public health concern, which affects social and economic development in developing countries. A cross-sectional study was conducted in three selected districts of the Afar region of Ethiopia to determine the seroprevalence of camel brucellosis. A total of 1152 camels from 168 camel herds were included in the study. All serum samples were consequently tested and confirmed serologically using Rose Bengal Plate Test (RBPT) and Complement Fixation Test (CFT). Risk factors analysis was also conducted using multivariable and univariate logistic regression analysis. As a result, 58 (5.0%) were RBPT reactors in which 47 (4.1%, 95% CI: 2.9 to 5.3%) were confirmed to be positive using CFT and at least one reactor camel was found in 37 (22.0%) of the total herds sampled. The statistical analysis indicated that herd size (OR=0.64; 95% CI: 0.42 to 0.98, P=0.04) and contact with other ruminants (OR=0.62; 95% CI: 0.47 to 0.82, P=0.001) were the major risk factors for the presence and transmission of the disease between animals. In addition, pluriparous (4.7%), abortive (5.7%), pregnant (6.6%) and lactating (4.1%) camels were found with higher seropositivity which contributed in the transmission of the disease to calves, other ruminants as well as to humans, but this was not a statistically significant association (P>0.05). In conclusion, camel brucellosis is prevalent in this area of study and there is a need for planning and implementation of joint programs by stakeholders in prevention and control of the disease as well as raising public awareness in decreasing the distribution of the disease in the area.

## **Seroprevalence and Associated Risk Factors of Camel (*Camelus dromedaries*) Brucellosis in and Around Dire Dawa, Ethiopia**

*Ismail Warsame, Sefinew Alemu, Wudu Temesgen and Wassie Molla. 2012. Global Veterinaria 8 (5): 480-483.*

A cross-sectional study of brucellosis was conducted from November 2010 to April 2011 to estimate seroprevalence and to assess potential risk factors of camel (*Camelus dromedaries*) in and around Dire Dawa, Ethiopia. Rose Bengal Plate test (RBPT) was used as a screening test to detect the presence of *Brucella* antibodies and CFT to confirm those reactors by RBPT. Thirteen of 646 camels (2%) were seroreactive when tested by RBPT, out of which 10 (1.5%) were seropositive by CFT. Higher seroprevalence was observed in females and adult camels with

seroprevalence of 1.7 and 1.8% than seroprevalence of 1.4 and 0.7% observed in male and young camels, respectively. However, there was no statistically significant difference ( $P < 0.05$ ) in the seroprevalence of brucellosis between both groups. Higher seroprevalence of *Brucella* (38.5%) was observed in adult female camels which had a history of reproductive problems [abortion, stillbirth and retained fetal membrane (RFM)] with statistically significant difference ( $P < 0.05$ ) compared to that of adult female camels which had no history of reproductive problems. Of camels that had these reproductive problems, the highest seroprevalence (43%) was observed in camels which had a history of abortion. In conclusion, this level of seroprevalence is enough to be a potential hazard for public health in the study area, therefore, the public especially camel producers should be aware of camels as a source of brucellosis.

## **Ticks and Mange Mites Infesting Camels of Boran Pastoral Areas and the Associated Risk Factors, Southern Ethiopia**

*Bekele Megersa, Abreham Damena, Jemere Bekele, Bedane Adane and Desie Sheferaw. 2012. J. Vet. Med. Anim. Health. 4(5), 71-77.*

A cross-sectional study was conducted on selected camel herds of Borana lowland, southern Ethiopia. From a total of 560 camels examined, 97.7 and 25.9% were found infested with ticks of various species and *Sarcoptes* species. A total of 4636 adult tick species were collected from half-body regions of selected camels. The tick species identified and their relative abundance were as follows: *Rhipicephalus pulchellus* (69.6%), *Amblyomma gemma* (12.4%), *Hyalomma dromedary* (10.8%), *Boophilusdecoloratus* (4.2%), *Amblyomma variegatum* (2.6%) and *Amblyomma Lepidium* (0.4%). *Sarcoptes* species were the only mange mites observed during this study in Borana lowland. The overall half-body region observed mean tick burden was 48.4 ticks/camel. The total half-body regions mean tick burden was significantly higher in young males (1 to 3 years of age) with poor body conditions, large herd size (greater than 40 camels), and IN wet season. Also mixing camels with sheep and goats, and cattle significantly affect the mean half-body tick burden of camels. However, the impact of ticks and mange mites on host camel and the environment was not measured during this study; it was concluded that the number and species of infesting ticks and mange mites encountered were significant enough to pose a potential health hazard. Further research work on the seasonal pattern, biology, and vector role for the ticks should be carried out in Borana lowland.

## **Prevalence of Gastrointestinal Parasites and Efficacy of Anthelmintics Against Nematodes in Camels in Yabello District, Southern Ethiopia**

*Kasahun Demelash, Fikadu Alemu, Ayalew Niguse and Teka Feyera. 2014. Acta Parasitologica Globalis; 5 (3): 223-231.*

A study, that comprised of a cross-sectional study and controlled field trial, was conducted from December 2013 to April 2014 with the objective of estimating the prevalence of gastrointestinal parasites in randomly selected 384 camels (*Camelus dromedaries*) and testing the efficacy of three anthelmintics, namely ivermectin, albendazole, and levamisole against nematodes in camels in Yabello district, Southern Ethiopia. For the prevalence study, a fresh fecal sample obtained from each animal was screened for the presence of gastrointestinal (GI) parasites egg using fecal floatation and sedimentation, whereas the infestation burden was determined by McMaster egg counting technique. Camels that had moderate to heavy egg counts (EPG of more than 400) were selected and used for the anthelmintics efficacy study. This included three treatments and one negative control group. Out of the 384 camels examined, 310 (80.73%) were



found to harbor different GI parasites. The result showed that 79.67% of eggs identified were those of *Trichostrongylus* followed by *Strongyl* species (59.67%). There was a statistically significant difference in the prevalence of GI parasites between age groups and the origin of animals ( $p < 0.05$ ) but not between the different body condition and sex groups. On the other hand, the degree of GI parasitic infestation between sex and age groups differed statistically ( $p < 0.05$ ) but no significant difference between the body condition groups. The efficacy study, as measured by fecal egg count reduction percentage (FECR %), also evidenced that of the three drugs studied, ivermectin at a dose of 0.2 mg/kg and albendazole at a dose of 10 mg/kg substantially reduced nematode egg counts post-treatment. Although slightly lower, levamisole (at a dose of 10 mg/kg) also considerably reduced the parasite burden. Taken as a whole, the present study established that camels in Yabello district harbor different GI parasites which could hamper the health and production status of this subject. Ivermectin and albendazole showed promising efficacy against nematodes and can still be considered as appropriate chemotherapeutic options for control of GI parasitosis in Camel.

## **Prevalence of camel trypanosomosis in and around Jigjiga, Somali region, Eastern Ethiopia**

*Ahmed Yusuf, 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted in Jigjiga and Gursum districts, Jigjiga Zone, Somali Region, Ethiopia from November 2011 to April 2012 with the aim of determining the current prevalence of camel Trypanosomosis in the study areas using a parasitological technique such as wet blood smear, thin blood smear, and micro-hematocrit centrifuge technique for packed cell volume determination. Blood samples were collected from a total of 264 camels managed under pastoral production systems. Out of the 264 camels examined, 14 were positive with an overall prevalence of 5.3%. In this study, the prevalence of camel Trypanosomosis in Gursum was relatively higher (7.87%) (10 out of 127) than that of Jigjiga (2.92%) (4 out of 13). However, the difference in the prevalence of camel Trypanosomosis within the two sites was not statistically significant ( $p > 0.05$ ). The prevalence of camel Trypanosomosis was higher in females (6.54%) than male (3.6%) with regarding age groups, the prevalence was high (5.3%) in adult camels and young were all negative. However, the difference in prevalence between sex and age groups was not statistically significant ( $p > 0.05$ ). The mean packed cell volume of parasitaemic camels (23.30) was significantly ( $p > 0.05$ ) lower than that of a parasitemic camels (29.87). The result of the present study showed that there is a lower prevalence of camel Trypanosomosis in the study areas during dry seasons of the year. Therefore, further studies should be conducted involving both dry and wet seasons of the year.

## **Prevalence of Camel Helminthiasis in Gashamo district, Somali Regional State, Ethiopia**

*Desalegn Asfaw, 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted from November 2011 to April 2012 to determine the prevalence and risk factors associated with camel (*Camelus dromedaries*) helminthiasis in Gashamo district of Degahabure zone, eastern Ethiopia. A total of 384 camels (57 males and 327 females) were examined using the standard parasitological procedure of flotation and sedimentation techniques for the presence of eggs of helminth parasites. Additionally, McMaster egg counting method was used to determine the helminth parasite burden. The study

revealed that the overall prevalence of helminthiasis was 59.6% (229/384). The prevalence was 56.8% in Quidel Libel and 64.6% in Bako peasant associations. Prevalence of individual helminth parasite were (36.9%) strongyle species, (19.1%) Trichuris, (7.4%) Monesia, (4.7%) parascaris, (4.2%) Ascaris, (3.7%) Strongyloides, (3.4%) Paramphistomum and (2.9%) Nematodirus. Strongyles were the most prevalent parasite followed by Trichuris. The prevalence rates in the four age groups examined were 75.7% (1-3 years), 65.2% (4-7 years), 58.7% (8-12 years) and 37.5% (greater than 12 years). The prevalence rates of helminth parasite infection in female and male camels were 58.4% and 66.7%, respectively. Statistically, a significant association was observed only between age and helminth parasite infection ( $\chi^2=21.84$ ,  $p=0.000$ ). Sex and peasant associations were shown to correlate with parasitic infection but significant difference was not found. About 16% of the examined animals were severely infected with the parasites moderate and 49.9% were lightly infected.

### **Prevalence, risk factors and major bacterial causes of camel mastitis, in Gursum district, Eastern Ethiopia**

*Jemal Mohamud 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted on lactating she-camels kept under the pastoral production system to determine the prevalence of mastitis, the impact of risk factors, and isolate the dominant mastitis-causing bacteria in selected areas of Eastern Hararghe Zone. The prevalence of camel mastitis was determined by mastitis indicator paper (MIP) and by clinical (gross) examination of udder and milk samples. Then the overall prevalence was calculated by dividing positive animals to total animal examined. A total of 316 traditionally managed lactating camels selected from three pastoral associations in Gursum district areas (Daketa, Noleyye, and Koree) were examined during the study period clinically and subclinical cases by using mastitis indicator paper. The overall mastitis prevalence was 31% (98/316) out of which, 6.3% (20/316) and 24.7% (78/316) camels showed clinical and subclinical mastitis respectively. Among MIP positive samples 98 samples were taken at animal level were cultured for identification of etiological agents of camel mastitis. The overall prevalence of mastitis observed in camel herds examined as assessed by MIP (for screening test) and clinical examination of the udder 31%, which indicates, the disease is prevalent in the area. This prevalence of mastitis in the camel herd examined could be attributed to the unhygienic condition followed by camel owners, a high infestation of a tick, and lesions caused by thorny desert plants. Risk factors like origin, tick infestation, and lesion were significantly associated with the camel mastitis in the study area ( $p > 0.05$ ). The bacterial species isolated from paper positive camel milk samples include coagulase-negative staphylococcus species (22.22%), coagulase-positive Staphylococcus (staph aureus=21%), Streptococcus agalactiae (10%), other streptococcus species (12.2%), Micrococcus species (4.4%), Escherichia coli (15.55%), Klebsella species (7.77%) and Bacillus species (6.6%). These results suggest that measures needed to be taken to improve the health of camels and the quality of camel milk in the study area.

## **Prevalence of camel trypanosomosis in and around Yabello District, Oromia Region, Ethiopia**

*Lidet Womie, 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study on camel trypanosomosis was conducted in Yabello district, Borana Zone, Oromia Regional State, Ethiopia from November 2011 to April 2012. The study was carried out to determine the parasitological prevalence of surra. Blood samples were collected from 305 camels (*Camelus dromedaries*) and examined for the presence of *Trypanosoma evansi* using the Giemsa Stained blood smear method. The overall parasitological prevalence of camel trypanosomosis was found to be 1.30%. Camels in Yabello district had a significantly lower parasitological prevalence of surra than the previous finding in the district 10.5%. Thus, this might indicate that camels in the dry season were less at risk of getting an infection than herds in the rainy and wet season in the study area. There was a statistically significant difference ( $p < 0.001$ ) in the mean PCV of parasitologically positive and negative camels. Although our result showed that the prevalence of camel trypanosomosis is significantly lower than the previous finding, it can be inferred that camel trypanosomosis is endemic in Yabello districts of Oromia region, Ethiopia, where it demands further study on identification of the principal vector species responsible for transmission and investigating the potential for vector control.

## **Investigation and molecular characterization of camelpox virus in selected districts of Jigjiga zone Somali region, Ethiopia**

*Yonas Gizaw, 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

Camel pox is an economically important contagious skin disease of camelids caused by the Orthopox camel virus which belongs to genus Orthopoxvirus within the family Poxviridae. The present study for the investigation and molecular identification of Camel pox virus (CPV) was initiated by the National Veterinary Institute (NV) to confirm the presence of the disease in the area and evaluate the isolated virus for the production of a highly efficient local vaccine. A cross-sectional study was conducted in order to investigate and identify the camelpox virus at the molecular level from November 2011 to April 2012 in selected districts of the Jigjiga zone, Somali Region, Eastern Ethiopia out of 400 camels examined during the study. Twelve (12) camels were found with typical clinical signs of camelpox which varies from mild localized to generalized pox lesions and sampled for laboratory analysis. In Vero cell culture, all of the suspected samples of the camelpox virus were successfully isolated showing characteristic plaque-type Cytopathic effect (CPE). Out of the twelve (12) samples showing CPE in Vero cell culture were further tested by polymerase chain reaction (PCR) and eleven (11) samples were positive showing amplicon sizes of 500 bp (base pair). The questionnaire survey indicates that camelpox is the most common disease in the study area in which 48(96%) of the respondents report the frequent occurrence of camelpox in their herds. The present study indicates that camelpox is prevalent in the study area which needs an effective control strategy. Therefore, special attention should be given on the epidemiological investigation and an integrated approach in the control of camelpox is required to obtain the maximum benefit of camel herding.

## **Parasitological survey of trypanosomosis (Surra) in camels in Fafen Zone, Somali Regional State, Ethiopia**

*Hassan Ahmed, 2013. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted from November 2013 to April 2014 with the objective of estimating the prevalence of camel trypanosomosis (SURRA) in Fafen Zone. The method employed was parasitological examination blood samples obtained from 343 randomly selected camels. The overall prevalence of camel trypanosomosis was found to be 5.83%(20/343). The prevalence of trypanosomosis did not significantly ( $p > 0.05$ ) differ between males of (5.4%) and females (6%), between adult (6.5%) and young (4.9%) camels and between large herds (7.8%) and small herds (4.2%). However, the prevalence of trypanosomosis was statistically ( $p < 0.05$ ) different between Fafen (13%), Jigjiga (3.6%) and Gursum (1.9%) districts, between camels which were herded together with shoats (9.8%) and those not herded together with shoats (3%) and between camels that were watered in a single watering point in a group of less than 50 camels (1.0%) and groups that had more than 150 camels (9.8%). The result of his study showed that camel trypanosomosis is prevalent in the Fafen zone and it is a disease of major economic importance in the area.

## **A study on Ticks Affecting Camels (*Camelus dromedarius*) in Jigjiga District of Somali Region, Eastern Ethiopia**

*Ahmed Hasan 2013. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was carried out from November 2013 to April 2014 to assess the prevalence of tick infestation and identify the species that parasitize camels in Jigjiga districts, Eastern Ethiopia. All visible adult tick specimens were collected from seven different predilection sites on the camel. Out of 384 of examined animals, 318 (82.8%) were found to be infested by ticks. A total of 5,090 adult ticks were collected, which belongs to eight different species of four genera and identified using direct stereo microscopy. The four genera of tick identified during the study period include. Rhipicephalus, Hyalomma, Amblyomma, and Boophilus. The most abundant tick species was Rhipicephalus pulchellus (37.5%) followed by Hyalomma dromedary (20.1%) Amblyomma germma (11.9%), Hyalomma truncatum (8.2%), Hyalomma marginatum rufipes (6.3%), Amblyomma variegatum (6.2%), Boophilus decoloratus (5.4%) and Amblyomma lepidium (4.6%). The highest infestation level of ticks was observed on the Udder /Scrotum (21%7%) and the lowest (5.4%) was observed on the Back/side of the animal's body region. The sex ratios of all tick species identified were skewed towards males except for B, decoloratus. The infestation rate of tick showed statistically significant variation ( $p < 0.05$ ) on the body condition of the animals. However, no association was observed ( $p > 0.05$ ) in the prevalence of tick infestation between the sex group, age group, and the origin of animals. Generally, this survey indicated that tick infestation is a core problem of Camel production in the study area. Therefore, special attention should be given for the programmed tick control campaign in the region.

## **A major cause of organ condemnation in camels slaughtered at Akaki abattoir, Addis Ababa, Ethiopia**

*Mekuanent Tenaw. 2014. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted from January to April 2014 to determine the major causes of carcass condemnation and the rate of organs condemned in camels slaughtered at Akaki abattoir, Addis Ababa. For the study, a meat inspection procedure involving both ante-mortem and post-mortem inspection was performed on a total of 385 camels and carcass. Upon ante-mortem inspection, disease conditions or abnormalities were found in 61 (72.62%) and 209 (69.44%) male and female camels, respectively. Out of total 385 camels slaughtered, 230 (59.74%) lungs, 34 (8.83%) livers, and 6 (1.55%) hearts were condemned. Among 84 male camels slaughtered, 52 (61.90%) lungs, 9 (10.71%) liver and 0 (0%) hearts were condemned; and out of 301 female camels slaughtered, 178 (59.13%) lungs, 25 (14.04%) livers encountered during post mortem examination, hydatid cyst, emphysema, and pneumonia were the major causes of lung condemnation whereas work revealed that a considerable number of organs was condemned from camel slaughtered at Addis Ababa Akaki Abattoir mainly due to different pathological lesions on different organs. This warrants the immediate need for the prevention of causes of organ condemnation and pathological abnormalities through the development of animal health strategies, enforcement of slaughter policy, and training of slaughterhouse personnel on standard slaughter operations.

## **Epidemiological and Therapeutic Studies of Camel Mange in Fafan Zone, Eastern Ethiopia**

*Ziad Abdillahi. 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

Camel mange is an economically important parasitic disease affecting productivity in camel rearing areas of the world if appropriate treatment is not instituted. A cross-sectional and a controlled field trial were carried out to study the epidemiology of camel mange in Fafan zone, Eastern Ethiopia, and evaluate the efficacy of ivermectin and diazinon in the control of mange infestation in camels on the basis of clinical and parasitological evidence, respectively. Three groups of naturally infested camels and one group of healthy camels each composed of 6 individuals were enrolled in the two infested groups received either ivermectin or diazinon, and the other groups remained untreated. The overall prevalence rate of mange in camels in the study area was 31.5% and the only identified species was *Sarcoptes scabiei*. The prevalence rate was found to significantly vary ( $p < 0.05$ ) in relation to body condition and herd size of camels. Both drugs showed significant variation ( $p < 0.05$ ) on improving clinical and body condition scores. Clearance of mange lesions occurred with both drugs; however, reinfestation was observed in the diazinon treated group. Ivermectin significantly improved ( $p < 0.05$ ) both body condition and clinical scores whereas diazinon markedly improved only later. In conclusion, camels in the study area harbored a considerable level of 5. Scabiei which warrants the institution of an integrated control approach by the administration of ivermectin while also sanitating the animal environment.

## **Seroprevalence of Camel Brucellosis in Yabello District of Borena Zone, Southern Ethiopia**

*Geremu Kaynata, 2012. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was carried out to estimate the seroprevalence and to assess associated risk factors of camel (*Camelus dromedaries*) brucellosis in the Yabello district of Borena zone, Southern Ethiopia from November 2014 to April 2015. A total of 384 blood samples were collected from camels of four pastoral associations selected by multi-stage cluster sampling and a questionnaire survey was administered to 46 willing respondents whose camels were included in the sample unit. The sera were initially screened with Rose Bengal Plate Test (RBPT) and those samples found positive by RBPT were further tested by Complement Fixation Test (CFT) for confirmation. Out of 384 sera, 14 (3.6%) were positive using RVPT and 12 (3.1%, 95% CI: 1.3 to 4.9%) were positive using CFT. The study showed no statistically significant difference ( $p>0.05$ ) in seroprevalence among the pastoral associations, contact with other ruminants, parity, herd size, and sexes considered. However, there was a statistically significant difference ( $p<0.05$ ) between age groups and those with a history of abortion. The questionnaire survey showed that all owners have no awareness about the zoonotic importance of the disease, drink raw milk, and did not take care of retained fetal membranes and aborted fetuses. Moreover, the current level of seroprevalence is enough to be a potential hazard for public health in the study area, therefore, public education about the zoonotic importance of brucellosis, controlling the risk of health personnel should be improved. Further, research that produces and develops effective vaccines against the strains of *Brucella* in camels should be conducted in pastoral communities.

## **Prevalence, Associated Risk Factors and Major Bacterial Causes of Dromedary Camel Mastitis in Selected Districts of Fafan Zone, Eastern Ethiopia**

*Mohamed Gaalle, 2015. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study of camel mastitis was conducted on 316 lactating camels from the Fafan zone between November 2014 to April 2015 to estimate the prevalence, associated risk factors, and major bacterial causes of mastitis. Prevalence of mastitis was determined by using the California mastitis test (CMT) and by clinical examination of udder and milk samples. From 316 she-camel examined from three districts in the Fafan zone (Gursum, Jigjiga, and Qabribayah) there was an overall camel mastitis prevalence of 36% (114/316), out of which 8.2% (26/316) and 27.8% (88/316) were clinical and sub-clinical mastitis respectively. The overall quarter level prevalence was 36.1% (456/1264), were blind. Out of 1,230 functional quarters, 34.3% (422/1230) were (CMT positive). Age, parity number, stage of lactation, tick infestation and presence of a lesion on udder/teat were found to be significantly associated with mastitis ( $p<0.05$ ). Microbiological examinations of 150 randomly selected CMT positive milk samples including clinical quarters, 128 samples were culture positive (97 were Gram-positive, 10 Gram-negative, and 21 mixed isolates). While 22 samples were culture negative. In addition to that, the majority of the isolates were staphylococcus aerus (26.1%), followed by coagulase-negative staphylococcus (18.7%) streptococcus dysagalactia (7.3%), *Escherichia coli*, *Bacillus* spp, (6.7%) and streptococcus agalactia (5.5%), Mastitis in the study area was found to be significantly high. Therefore, good hygiene in the milking process, elimination of anti suckling

device practice, proper treating of an affected animal with susceptible drugs, could reduce the prevalence of mastitis in the study area.

## **Epidemiology of Ticks Infesting Camel in Selected Districts of Fafan Zone, Ethiopia**

*Kader Maalin, 2014. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted from November 2014 to April 2015 to determine the prevalence and risk factors associated with a tick infestation in camels in selected districts of Fafan zone, Eastern Ethiopia. Six peasant associations were selected to determine the prevalence and species composition of ticks infesting camels and to identify those factors that could contribute to the occurrence of these parasites. For this purpose, each animal was thoroughly screened for the presence of ticks and all visible adult tick specimens in different anatomical. From a total of 450 camels examined, 78.6% were found infested with ticks of various species. A total of 4767 adult tick species were collected from the half-body region of a selected camel which belongs to seven different species of four genera and identified using a direct stereo microscope. The four genera of ticks identified during the study period include Hyalomma (43.1%), Rhipicephalus (36.9%), Amblyomma (16.2%) and Boophilus (3.7%). The tick species identified and their relative abundance were as follows: Rhipicephalus pulchellus (36.9%), Hyalomma dromedarii (21.5%), H. truncatum (13.5%), Amblyomma gemma (10.9%), H.m. rufipes (7.9%), Amblyomma variegatum (5.3%), and Boophilus decoloratus (3.7%). The prevalence of tick infestation in body condition score showed statistically significance variation ( $p < 0.05$ ). However, no significant association was observed in the prevalence of tick infestation between sex, age, and origin of the camels ( $p > 0.05$ ). Generally, this survey indicated that tick infestation is a core problem of camel production in the study area. Therefore, further study and appropriate control measures are recommended to improve the health and productivity of the camel.

## **Prevalence of Camel Gastrointestinal Helminthes in Selected District of Fafan Zone, Eastern Ethiopia**

*Hassan Abdi 2014. Compendium of DVM Thesis Abstracts College of Veterinary Medicine Jigjiga University Directorate of Research, Publication and Technology Transfer*

A cross-sectional study was conducted from November 2014 to June 2015 with the objectives of estimating the prevalence of gastrointestinal (GIT) helminthes affecting camels and to determine the risk factors associated with gastrointestinal helminthes infestation of camels in Jigjiga and Gursum district of Fafan zone. Collected fecal samples were subjected to flotation and sedimentation, and MacMaster counting techniques to identify the type of helminthes parasites and to determine the burden of infestation, respectively. The fecal examination revealed that the overall prevalence of 77.3%. Out of 238 sampled 184 of camels excreted helminthic eggs in the feces. The most common encountered parasite was Strongyle spp.(33.6%), Trichostrongylus spp. (25.6%), Strongyloid spp.(25.6%), Nematodirus spp.(19.7%), Trichuris spp.(15.5%), Haemonchus spp. (14.7%) and Monezia spp. (8.4%). The overall mean of egg count was relatively higher 847.55, in this study there was a significant difference in the mean egg count based on sexing which female was found to have higher egg count than males. Similarly, statistically significant differences in mean egg per gram of feces were observed among other risk factors like age, body condition score, and fecal description ( $p < 0.05$ ). All the hypothesized factors such as origin, body condition score, age, and fecal description expect sex

affected significantly ( $p < 0.05$ ). The present study showed that the gastrointestinal helminthes are an important health problem that affects the well being and productivity of the camels. More emphasis should be given to appropriate prevention and control design using strategic deworming with suitable anthelmintics in camel herds of the study area.

## **A Seroprevalence Study of Camel Brucellosis in Three Camel Rearing Regions of Ethiopia**

*Teshome H., Mola B and Tibbo M. 2003  
J. Trop. Anim. Health. Prod. 35 (5): 381-390*

A cross-sectional investigation was made into the seroprevalence of brucellosis in camels in three arid and semi-arid camel-rearing regions of Ethiopia (Afar, Somali, and Borena) between November 2000 and April 2001. When sera collected from 1442 accessible camels were screened with the Rose Bengal plate test (RBPT), 82 (5.7%) of them reacted. The results of a complement fixation test (CFT) on those sera that had given a positive reaction to the screening test then indicated a 4.2% prevalence of brucellosis in the tested camels. There was a significant difference in the prevalence of brucellosis ( $\chi^2 = 7.91, p < 0.05$ ), which was highest in Afar (5.2%) followed by Somali (2.8%) and Borena (1.2%) regions. Camels in Afar had a four times higher risk of brucellosis with an odds ratio (OR) of 4.34 (confidence interval, CI = 1.76–10.72,  $p < 0.001$ ) compared to the risk in Borena. Likewise, Afar had a higher risk (OR = 1.76, 1.13–2.74,  $p < 0.05$ ) than that in Somali. There was no significant difference in seroprevalence between the sexes ( $p > 0.05$ ). Although a higher prevalence (6.3%) was observed in camels over 3 years old in Afar, there was no significant overall age difference ( $p > 0.05$ ).

## **Prevalence and Risk Factor of Brucellosis in Dromedaries in Selected Pastoral Districts of Afar, Northeastern Ethiopia**

*Fikre Zeru, Kidanie Dessalegn, Sisay Tilahun, Yimer Guben,  
Hussen Mohammed and Angesom Hadush. 2016  
Journal of Natural Sciences Research Vol.6, No.1, 2016*

A cross-sectional study was conducted on 813 camels from 63 herds in selected Afar pastoral areas from May 2012 to February 2013 to determine the prevalence and risk factors associated with camel brucellosis. A serum sample was collected and screened for brucellosis using the Rose Bengal Plate Test followed by the Complement Fixation Test of positive samples for confirmation. The herd-level seroprevalence was 17.46% and varied significantly among different herd sizes ( $\chi^2 = 8.84; P < 0.05$ ) and contact with small ruminants ( $\chi^2 = 3.91; P < 0.05$ ). Camel herds in contact with small ruminants were 6.64 times (OR=6.64; 95% CI: 1.30-33.88) more at risk for brucellosis infection than those herds which had no contact with small ruminants. Animal level seroprevalence was 2.09% and varied significantly among different herd sizes ( $\chi^2 = 8.079; P = 0.018$ ). The prevalence of brucellosis was significantly higher in camels with a history of abortion (6.67%) ( $\chi^2 = 10.534; P = 0.032$ ). Sex, age, body condition, physiological status, and parity were insignificantly associated ( $P > 0.05$ ) with the prevalence of brucellosis. The present study suggests that *Brucella* infection is the likely cause of abortion in camel and small ruminants were the probable source of *Brucella* infection for camels in the study. On the other hand, based on the observation of the author, none of the camel herdsmen knew the disease and the prevailing habit of consumption of raw camel milk and the man-animal close contact in the Afar pastoral area demonstrate the potential role of brucellosis as a zoonosis in the area. Therefore, improving management practices, public awareness, economic and zoonotic importance of the disease can assist disease prevention.



## **Camel Trypanosomiasis in Babile District, Eastern Hararghe Zone, Oromia Region of Eastern Ethiopia**

*Tayib Mohammed, Mezene Woyessa, Tadesse Brihanu and Adem Hiko 2015  
Academic Journal of Animal Diseases 4(3): 141-145*

A cross-sectional study was conducted to determine the prevalence of camel trypanosomosis, and assess associated potential risk factors in four localities of Babile district, eastern Hararghe zone, Oromia Regional State, eastern Ethiopia from November 2014 to April 2015. Randomly selected camels were blood-sampled and examined for *T. evansi* infection by Wet film, Giemsa-stained thick/thin smears, and Buffy coat technique. Out of 384 examined camels, 31 (8.1%) were positive for Trypanosome evansi. There was a statistically significant difference between the prevalence of camel trypanosome and study site (peasant association), sex, and age of the animals ( $P < 0.05$ ). The highest prevalence of the disease was observed in Erer-ibada (12.3%) whereas the lowest prevalence value was recorded in the Rahmata site (3.3%) during the study period. The prevalence was higher in females (8.9%) than male (5.5%) camels. Adult camels (10.5%) were infected more than young camels (4.9%). The mean PCV was lower (23.1%) in parasitemic animals as compared to aparasitemic animals (28.1%). There was no statistically significant difference observed between infection and PCV. The result of the current study revealed that camel trypanosomosis was highly prevalent in the study area. Thus, there is a need for designing control and prevention strategies as well as identifying risk factors.

## **A Study on the Productivity and Diseases of Camels in Eastern Ethiopia**

*Tefera and Fiseha Gebreah. 2001.  
J. Trop. Anim. Health. Prod. 33 (4): 265-274.*

A study concerning performance traits of the Ethiopian camel indicated that in the camel herds examined, there was one active bull camel for 25 females. The bull camel was 5 years old at puberty; it reached rutting vigor at the age of 9 years, the number of mountings per day was 8 during the breeding season, and the reproduction span was 10 years. The female camel reached puberty at 4 years of age; the age at first calving was 5 years, and the lactation period was one year; the calving interval was 2 years, the calving rate was 50%, and the reproduction span was 10–15 years. The survival rate of the newborn calves was 50%. The average milk yield was 2.5 L per day; the price of camel's milk was higher than that of cow's milk at US\$0.5. Adult camels weighed around 500 kg; the dressing-out percentage was 52%. Mutton was preferred to camel meat, which came second in popularity, costing US\$2/kg. Owing to their poor reproductive performance, camels are not efficient for producing meat. The camels worked for 16 h per day, covering 60 km. Animal health problems encountered were trypanosomosis, camelpox, camel pustular dermatitis, camel cephalopsia, dermatomycosis, mange mite, tick infestation, and balantidiosis, most of which mainly affected the young animals.

## **Major Diseases of Camel Calves in Borana of Southern Ethiopia**

*Bekele Megersa. 2014*

*African Journal of Basic and Applied Sciences 6 (6): 159-165.*

The study investigates major camel calves' diseases in Borana of southern Ethiopia. A total 551 of calves were seasonally investigated and 663 clinical cases were recorded. The most prevalent diseases were sarcoptic mange (47.9%), ticks (25.6%), contagious skin necrosis (15.8%), abscess (19.2%), contagious ecthyma (9.4), camelpox (6.5%), diarrhea (5.1%) and respiratory infections (4.5%). Seasonal patterns of the diseases showed that mange mite was more prevalent during the dry than wet periods while contagious ecthyma, pox, respiratory infection, and dermatophytosis were higher during the wet seasons. Large proportions of calves (over 70%) were also positive for internal parasites including *Strongyloides*, *Strongyloides papillosus*, *Monezia*, and *Eimeria* species, suggesting the importance of parasitic burden. Deaths have been recorded in 18.1% of the calves with the major causes being septicemic diseases (35%), respiratory infections (22%), sunken eye or Elgof (11%), and calf diarrhea (11%). Mortality was significantly higher for the wet season than a dry period and had decreased with increasing age. Additionally, the prevailing tradition of restricting colostrum intake among pastoralists and poor veterinary services might have a putative role on the increased early mortality of camel calves and thus calls for improvements.

## **Hard Ticks of camels in Southern Zone of Tigray, Northern Ethiopia**

*Semere Kiros, Nesibu Awol, Yisehak Tsegaye and Birhanu Hadush. 2014.*

*Journal of Parasitology and Vector Biology, 6 (10): 151-155.*

This cross-sectional study was carried out in Raya Azebo district with the objective of determining the prevalence and species diversity of hard ticks encountered in camels. During the study period, a total of 384 camels were examined and 96.6% of them were found infested with ticks. A total of 15,723 ticks were collected from half body regions of infected camels during the study period. The average tick burden from half body region of camels was  $42.4 \pm 19.63$ . Four genera and ten species of hard ticks were identified. The genera identified are *Amblyomma* (11.11%), *Boophilus* (1.8%), *Hyalomma* (23.32%), and *Rhipicephalus* (61.77%). The tick species identified during the study period were *Amblyomma variegatum*, *Boophilus declaratus*, *Amblyomma cohaerence*, *Rhipicephalus evertsi*, *Rhipicephalus pulchelis*, *Amblyomma aagemma*, *Amblyomma lepidum*, *Hyalomma rufipes*, *Hyalomma dromedarii*, and *Hyalomma truncatum* at a prevalence of 22.9, 16.7, 23.2, 41.5, 92.7, 7.8, 3.4, 47.4, 42.7 and 8.9%, respectively. Further study and appropriate control measures are recommended to improve the health and productivity of the camel.

## **A Study on Camels Ticks in and Around Dire Dawa, Eastern Ethiopia**

*Ayele Taddese and Mohammed Mustefa 2013*

*Acta Parasitologica Globalis 4 (2): 64-70*

A cross-sectional study was carried out from September 2010 to March 2011 to assess the prevalence of tick infestation and identify the species that parasitize camels in and around Dire Dawa, Eastern Ethiopia. All visible adult tick specimens were collected from seven different predilection sites on a camel. Out of 384 of examined animals, 361(94%) were found to be infested by ticks. A total of 11774 adult ticks were collected, which belongs to seven different

species of four genera and identified using direct stereo microscopy. The four genera of ticks identified during the study period include Rhipicephalus, Hyalomma, Amblyomma, and Boophilus. The most abundant tick species was Rhipicephalus pulchellus (46.78%), followed by Hyalomma dromedarii (26.85%), Amblyomma gemma (11.35%), Hyalomma truncatum (7.19%), Hyalomma marginatum rufipes (3.95%), Amblyomma variegatum (2.59%) and Boophilus decoloratus (1.24%). The highest infestation level of ticks was observed under-tail (27.62%) and the lowest (1.24%) observed on the back or side of the animal's body region. This survey showed that the infestation rate of ticks was 148 (90.2%) in males and 213 (96.8%) females camels. The infestation rate was varied significantly ( $p < 0.05$ ) in the prevalence of tick infestation between the age groups and among the body condition of the animals. Generally, this survey clearly indicated that the prevalence of tick infestations was a core problem in livestock production in the study area. Therefore, special attention should be given for the programmed tick control campaign in the region.

## **Microbiological Assessment of Meat Contact Surfaces at Abattoirs and Retail Houses in Jigjiga Town Somali National regional state, Ethiopia**

*Henok Ayalew, Amare Berhanu, Berhanu Sibhat and Biressaw Serda 2015*  
*ISABB - J. Food. Agri. Sci. 5 (3): 21-26*

This study was conducted to determine the microbiological quality and hygienic levels of meat contact surfaces at the abattoir and retail houses in Jigjiga town, Ethiopia. A total of ninety pooled swab samples were taken from the abattoir floor surface, butchers' hands, hooks and knives, and cutting boards to assess the presence and load of Staphylococcus aureus, Escherichia coli O157: H7, Listeria monocytogenes, aerobic bacteria (aerobic plate counts or APCs), fecal coliforms (FCs), yeast and molds (Y&Ms), and Campylobacter spp. Based on the data obtained, the highest average S. aureus and E. coli O157: H7 counts were found in retail houses ( $6.43 \pm 0.34$  cfu/cm<sup>2</sup>) and abattoir ( $6.03 \pm 0.03$  cfu/cm<sup>2</sup>) butchers' hands respectively. Campylobacter species were detected only from the abattoir floor surface. Overall, 3.33% of the samples were positive for Campylobacter spp. L. monocytogenes were not detected in any of the meat contact surface samples. The highest FCs ( $6.25 \pm 0.075$  log<sub>10</sub> cfu/cm<sup>2</sup>) and Y&Ms ( $5.19 \pm 0.513$  log<sub>10</sub> cfu/cm<sup>2</sup>) counts were found in the abattoir floor surface while the highest APCs ( $6.08 \pm 0.126$  log<sub>10</sub> cfu/cm<sup>2</sup>) were found in butchers' hand. According to this result, abattoir and retail meat contact surfaces might be considered as sources of meat contamination. Therefore, good hygienic practices should be introduced in order to enhance the overall microbial quality and hygienic level of meat contact surfaces and safeguard the consumer from foodborne pathogens.

## **Studies on Major respiratory Diseases of Camel (*Camelus dromedarius*) in Northeastern Ethiopia**

*Fekadu Kebede and Esayas Gelaye 2010.*  
*Afr. J. Microbio. Res. 4 (14): 1560-1564.*

A comparative serological test was carried out to identify the primary causative agent involved in the camel respiratory disease outbreak that occurred in Ethiopia. The samples were collected during and post-outbreak time and analyzed for Parainfluenza-3 and pasteurellosis. According to the result, Parainfluenza-3 was found as a primary causative agent as 70.5% in the outbreak and 6.8% in surveyed areas and there is a statistically significant variation observed between the outbreak and survey sera samples ( $P < 0.01$ ). *Manhaemiya hemolytica* was involved as

secondary bacterial complications. The association of *Parainfluenza-3* and pasteurellosis was also assessed and has shown that *M. haemolytica* A2 was a dominant serotype over others which accounts for 50% in higher antibody titration ranging from 1:80 - 1:320 in outbreak samples. Camel respiratory diseases are still flaring up in various parts of the country and reports are coming year after year urging for intervention measures. Further studies have been recommended on the epidemiology of the disease and the identification of the responsible pathogens and its serotypes to be involved in the development of vaccines.

## **Assessment of Traditional Breeding Program, Productive and Reproductive Performance of Camel in Borana Zone, Southern Oromia, Ethiopia**

*Bantayehu Muluneh, Tamirat Tessema and Bedhasa Eba*

Assessment of traditional camel breeding activity was performed inside potentially selected four PAs of Borana zone. A structured questionnaire was used to interview a total of 60 camel producers and collect socio-economic, traditional herd management, and production data. A descriptive statistic procedure of SAS was used to organize and analyze the data collected. The average herd size/HH have been  $34.50 \pm 25.03$ ,  $26.33 \pm 19.78$ ,  $29.83 \pm 23.62$ ,  $34.00 \pm 36.44$  respectively, for Elweya, Denbi, Bokola, and Surupha Pastoral association. The primary choice of pastoralists from all livestock species kept in the study sites was Camel, followed by a goat, cattle, and finally sheep with a respective index value of 0.483, 0.255, 0.251, and 0.011. The trend of the camel population is recognized as steadily increasing (60.90% of respondents) since the past three Gedas (24 years ago). Occupation (1<sup>st</sup>) commercial use (2<sup>nd</sup>) and transportation (3<sup>rd</sup>) have been found the first three major breeding objectives of the camel producing community in the study sites. Body confirmation (1<sup>st</sup>), Milk yield of the dam (2<sup>nd</sup>) and Size for male (3<sup>rd</sup>) and Milk yield (1<sup>st</sup>), Body conformation (2<sup>nd</sup>), and growth rate of calving (3<sup>rd</sup>) are the major selection criterion identified. Due to the previous fact that the area is vulnerable to frequent and catastrophic climate change plus the result obtained from the current study indicated that camel is becoming the most important livestock species in the area. Except for the Gebra community who has been known as long-lasting camel producers of the area, the Borana community is recently started rearing camel. as a result, frequent extension program regarding, Improved breeding, health, and feeding management is required to enhance the efficient utilization of the resource in the study area.

## **Characterization of Camel Feed Resources in Ethiopian Somali Regional State**

*Bosenu A., Kefyalew G., Aklilu B., Gebremedhin G. and Hassen A.*

The study was conducted in five administrative zones of Ethiopian Somali Regional State, with the objectives of characterizing the seasonal camel feed availability in pastoral and agro-pastoral areas and assessing possible improvement options of camel feeds. A semi-structured questionnaire, group discussions, field observations, key informant interviews, and secondary sources were used to gather data on camel feed resources. A total of 150 households were selected purposively for this study. The result showed that most of the respondents were male (90.7%). Of the sampled households in the study districts, about 85.3, 13.3 and 1.3 % were illiterate, read and write only, and primary school, respectively. The high percentage of illiterate compared to the other categories can hinder the adoption of agricultural technologies in the study area. Results showed that during the dry and wet season, browsing trees and shrubs, sorghum and maize stover were the major feed resources utilized as camel feed. Eighty-eight

percent (88%) of the respondents indicated that during wet season browsing trees and shrubs were the major feed resource. In the dry season, browsing trees and shrubs (64%) was the major feed resource followed by natural pasture (30.7%). The browse plant species identified in the study districts were trees species, herbaceous species, and shrub and bush species. Results from questionnaires and group discussions revealed that 15 herbaceous plants, 36 tree plants, 15 shrub species, 12 bush species, and 8 grass species used as a camel feed were identified in the study districts. Camel feed production using cultivated forage species is not commonly practiced in the study areas. About 97.3% of the sampled households in the study districts did not have improved forages, shrubs, or trees on their land for their camels. In the study districts, the major reasons for not planting improved camel feeds include lack of awareness (87.3%), shortage of rainfall (100%), shortage of land (3.3%), shortage of forage seeds (6.7%), and lack of interest of agro-pastoralists (5.3%). In the Degehabur, Kebridahar, Warder, Hamaro, and Dhekasuftu districts, 76.7, 93.3, 100, 100, and 86.7% of the respondents, respectively replied that there was communal rangeland in their areas. About 100% of the respondents indicated that communal rangeland was decreasing. Drought, deforestation, overgrazing, increased settlement, and limited knowledge of the pastoralists and agro-pastoralists were the common factors that cause rangeland deterioration throughout the districts. The result of the present study revealed that some of the respondents in all districts practice clearing of unwanted woody species, range enclosures, and land resting on their privately owned plots. Modern rangeland management systems have not been practiced in all districts. About 76% of respondents provided salt for their camel as a mineral source. The percentage of respondents supplying other mineral sources other than salt was 86.7, 66.7, 90.0, 53.3, and 50.0% in Degehabur, Kebridahar, Hamaro, Warder, and Dhekasuftu districts, respectively. About 87.3% of respondents provide adequate mineral supplementation to their camels. Poisonous plants were the major problems for camel production in all study districts. About, 100% of the respondents knew poisonous plants that affecting their camels. This study has concluded that there is a wide range of types of trees and shrubs, herbaceous and grass species in the study areas. The findings of the survey have indicated that, browse plant species have a major contribution in diet improvement for a camel during the dry season as many of the tree species keep their leaves green up to the end of the season. The study has also revealed the need to raise awareness among the pastoralist and agro-pastoral communities in the area with a focus on the importance of browse plant management and sustainable utilization. In general, the reduction of availability of camel feed throughout the study areas has resulted from drought, deforestation, overgrazing, and encroachment of rangeland. It is recommended that, browse plant species that were common feeds for camel and that have potential nutritive values should be managed, and the pastorals indigenous knowledge on rangeland management to be legalized. Awareness creation and regional support on the cultivation of improved legume trees, shrubs, and forage species should also be crucial.

## **Climate Change Risk Management and Coping Strategies for Sustainable Camel Production in the Case of Errer and Dembel District of Siti Zone, Somali Region, Ethiopia**

*Fano Dargo, Gebremedihin G/silassie, AkliluBajigo and Hassen Abdurehman*

Camel is still the main source of income for rural populations in the Ethiopian Somali region. However, many factors among which climate change are threatening the production systems. Climate change in agriculture could be devastating in many areas. Many regions already feel these impacts, which will get progressively more severe as mean temperatures rise and the climate becomes more variable. Ethiopia Somali region is one of the many regions of Ethiopia where climate change has severely affected the camel production. The climate change risk management and suitable coping strategies in relation to camel production in the Somali region

are not yet studied. Therefore, the current study is very crucial to assess climate change risks management and coping strategies for sustainable camel production. A study was carried out in the districts of Error and Dembel Woreda of Siti Zone of Ethiopian Somali regional state. The primary and secondary data were collected to assess Climate Change Risk Management and Coping Strategies for Sustainable Camel Production and information whose dissemination was underway on the production of a camel. During this study, 20 households were purposively selected from every four kebeles of the two woredas. A total of 80 respondents were purposively selected and interviewed using a semi-structured questionnaire. Simple Descriptive statistics were used to assess Climate Change Risk Management and Coping Strategies for Sustainable Camel Production. A total of 19.6% of the respondents suggested that the impact of climate was Camel disease incidence, Feed shortage, and Water shortage equally. Whilst Abortion, Camel Market failure, Sudden death of Camel, and Heat stress with 17.2%, 8.8%, 7.8%, and 7.4% respectively. Furthermore, the study has shown that climate change impacts negatively on camel production and thus camel owners need to use climate change risk management and coping strategies. Out of the total respondent, 24.8% of the household used Temporary camel relocation to other zones as climate change risk management and coping strategy. While, Restocking, Planting drought-tolerant browses trees and Conserving rainwater were the next strategies with 16.8%, 16.1%, and 13.7% respectively. This study concluded that information on the impact of climate change on camel production and climate change risk management and coping strategy has great potential to improve sustainable camel production if widely disseminated among the studied districts. Awareness creation among pastoralists and agro-pastoral regarding the dangers of climate change, and risk management and coping strategies for sustainable camel production, vigorous dissemination of the technologies/information, and follow-up to ensure utilization and/or application are strongly recommended. Besides, the government should also assist camel farmers with reliable water sources such as canals and dams.

## **Bacteriological Quality of Raw Camel along the Market Value Chain in Fafen Zone, Ethiopian Somali Region**

*Tesgalem Abera and Yoseph Legesse 2016*

*The 4th National Conference on Science and Technology for Sustainable Pastoral Development, March 26-27, 2016.*

The camel is a multipurpose animal with huge productive potential. Camel milk is a key food in arid and semi-arid areas of the African and Asian countries. The quality of milk is influenced by different bacteria present in milk. This study was conducted to evaluate total bacterial content in raw camel milk along the market chain Fafen zone. One hundred twenty-six raw camel milk samples were collected from Gursum and Babile Districts. All milk samples were analyzed for total bacterial counts and coliform counts. The overall mean total value bacterial and coliform count of camel milk collected in the study area was  $4.75 \pm 0.26$  log cfu/ respectively. The total viable count showed a significant difference ( $p < 0.05$ ) between the number of microorganisms recovered from the udder and milking bucket from the market level. *Staphylococcus* spp (89.8%), *Streptococcus* spp (53.7%), *E.coli* (31.5%), *Salmonella* spp (17.6%), *Kleibseilla* (5.65%) and *Enterobacter* (5.6%) were the major bacterial microorganism isolated. The majority of the bacterial isolates in the study area showed a high incidence in the market as compared to the production level. These results indicate a lack of compliance with good production practices and hygiene at milking, transportation, and market of raw camel milk.

# **Morphological Diversities and Eco-geographical Structuring of Ethiopian camel (*Camelus dromedarius*) populations**

*T. Yosef, K. Keefelegn, Y. K. Mohammed, U. Mengistu, A.*

*Solomon D. Tadelle J. Han. 2014.*

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The objectives of this study were to identify and characterize indigenous camel ecotypes and to assess phenotypic diversity and the relationship of camel populations in Ethiopia. A total of 494 heads of camels were investigated for phenotypic characterization. The study involved Jijiga, Liben, Gelleb, Hoor, and Shinille from Somali as well as Amibara and Mille camel populations from Afar national regional states, which are the major camel rearing areas. The results showed that the average barrel and heart girths of the Liben camel population were significantly ( $p<0.05$ ) larger than the remaining camel populations. Gelleb camels were significantly ( $p<0.05$ ) superior for morphological variables particularly height at shoulder, chest depth, chest width, and hip-width to other camel populations examined. Females of the Amibara camel population recorded significantly ( $p<0.05$ ) lower values for traits mentioned above as compared to other camel populations. The greatest morphological divergence was observed between Mille and Shinille followed by the difference between Amibara and Shinille camel populations. The least morphological divergence was detected between Hoor and Gelleb followed by that between Amibara and Mille camels in aggregate gender. The quantitative and qualitative study indicated that Jijiga and Hoor camel populations are milk type whereas Liben and Gelleb camel populations are meat type. The principal component analysis showed that body height traits and body height together with body shape traits explained most of the shared variability in female and male camel populations, respectively. The canonical analysis identified two canonical variables to be significant ( $p<0.0001$ ) and sufficient to classify all camels studied. Combined differences among all morphological variables categorized these seven Ethiopian camel populations into five major camel groups. Therefore the findings from this study can be used for the description of body conformation, characterization, improvement, and conservation of various camel populations in the country.

## **Characteristic Features, Genetic Diversity and Husbandry Practices of Ethiopian Camel (*Camelus dromedaries*)**

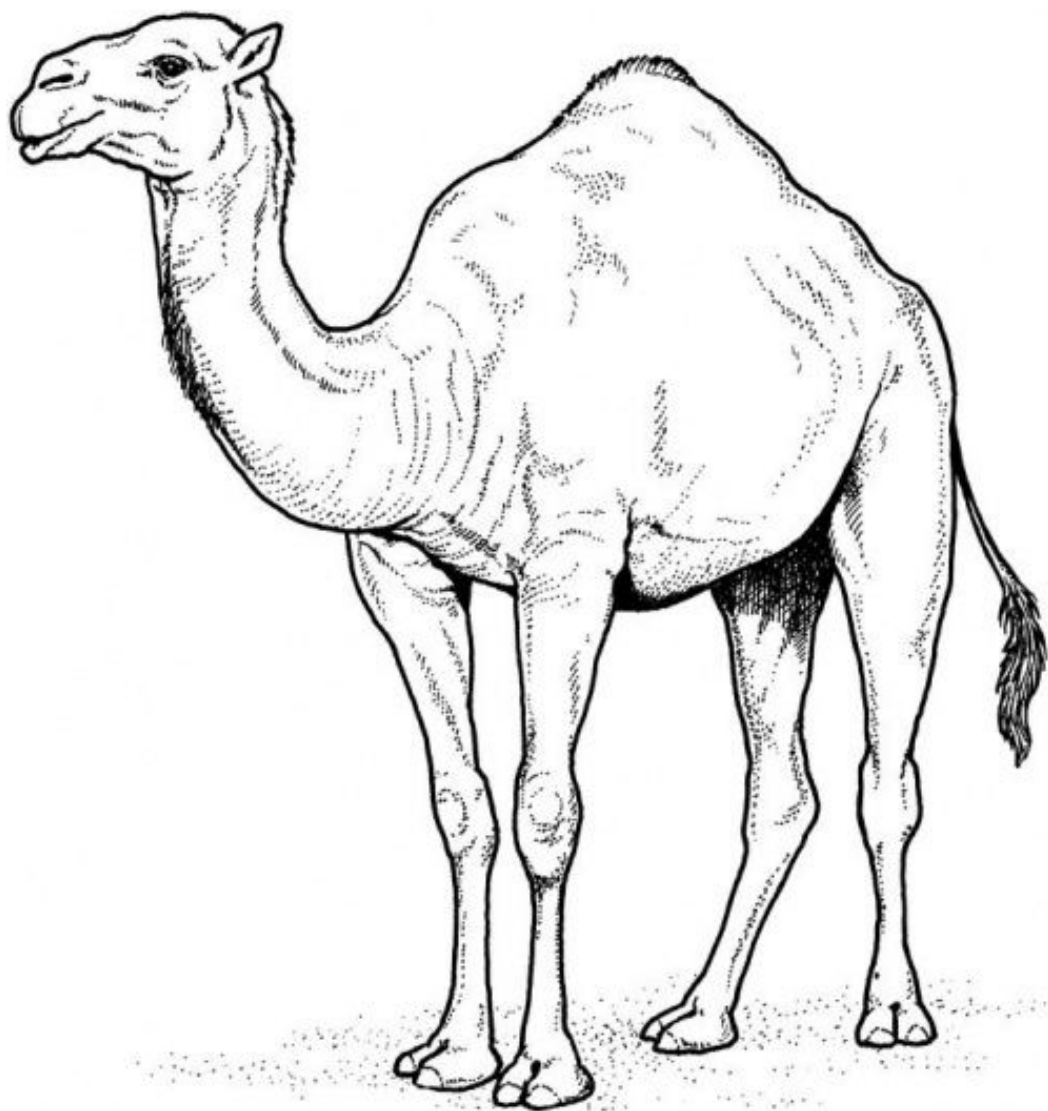
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The objectives of this study include identification and characterization of indigenous camel ecotypes, the study of the distribution and features of camel populations and husbandry practices, assessment of camel population dynamics, and the genetic diversities and population structure of camel populations of Ethiopia. The study locations were Jijiga, Liben, Gode, and Shinille from Somali and Amibara and Mille from Afar national regional states, which represent the major camel rearing areas. The results show that camels from Gode (Gelleb) were significantly ( $p<0.05$ ) superior for morphological variables particularly height at shoulder, chest depth, chest width, and hip-width to other camel populations examined. The average barrel and heart girths of the Liben camel population were significantly ( $p<0.05$ ) larger than the remaining camel populations. Females of the Amibara camel population recorded significantly ( $p<0.05$ ) lower values for traits mentioned above as compared to other camel populations. Quantitative and qualitative studies indicated that Jijiga and Hoor (Gode) camels are milk type whereas Liben and Gelleb camels are meat type. The principal component analysis showed that body

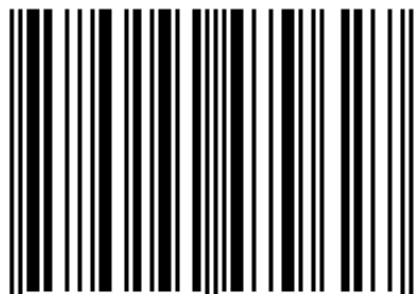
height traits and body height together with body shape traits explained most of the shared variability in female and male camel populations, respectively. For the study of genetic diversities and population structure of camel, blood samples were collected from 114 camels belonging to six populations (17-24 per population) and DNA was extracted and genotyped using 10 camel microsatellite marker loci. The results revealed the presence of high genetic diversities within Ethiopian camel populations with average observed, expected heterozygosity, the total number of alleles (TNA), Mean Number of Alleles (MNA) and an effective number of alleles of 0.55, 0.73, 153, 6.8 (0.36), 4.47 (0.23), respectively. Of the 52 private alleles in the six Ethiopian camel populations, 31 of them were occurring at a frequency of  $\geq 5\%$ . Most of the variation in Ethiopian camels is attributed to within-population variation (92%) while only 8% was explained by between populations' variations. The between-population differentiation ( $F_{ST}=0.105(0.01)$ ) indicates moderate population differentiation in Ethiopian camel populations. All the models and tests indicated the occurrence of the genetic bottleneck ( $P<0.05$ ) in the Jijiga camel population in the recent past. Genetic diversity study based on mtDNA markers was carried out to investigate the mitochondrial DNA (mtDNA) genetic diversity of the seven morphologically identified Ethiopian camel populations (Amibara, Mille, Shinille, Jijiga, Gelleb, Hoor and Liben). We also used DNA from the tissue of five different camel populations, namely the Arabian Peninsula (Oman and Yemen), Punt land, Sudan, and Egypt. We also retrieved 8 in-group (Camelus dromedaries) and 9 out-group (Camelus bacterianus and Lamma Glama) previously published mtDNA partial D-loop sequences from the GenBank (8 in-group from Saudi Arabia, 9 out-group (Bacterian) from Chinese and 1 out-group from South America camel populations) to trace the matrilineal genetic origin of camel populations. Genetic relationships and other diversity parameters in these populations were inferred from 59 randomly selected mtDNA D-loop sequences sequenced for 559 base pairs (bp). The result indicated that camel populations from the Arabian Peninsula, Saudi Arabia, East Africa (Ethiopia, Sudan, and Puntland) and Egypt have average numbers of haplotypes, haplotype diversity, and nucleotide diversities of 13,  $0.68\pm 0.13$  and  $0.0023\pm 0.002$ , respectively. This implies the low genetic differentiation among camel populations in the study area. Among all camel populations studied Oman and Ethiopia (Shinille, Amibara, and Hoor) have equal and the highest haplotype diversity ( $1\pm 0.11$ ), nucleotide diversity ( $0.00359\pm 0.001$ ), and an average number of nucleotide differences (2). The lowest haplotype diversity, nucleotide, and the average number of nucleotide differences were observed in Liben ( $0.33\pm 0.13$ ,  $0.00060\pm 0.003$ , and 0.33, respectively). All the DNA polymorphism shows that camels in Ethiopia have high mtDNA variation. The founder haplotype (C2) and the second-largest haplotype (C4) in frequency were largely found in camels of the Horn of African origin (Ethiopia and Puntland). Likewise, camels of this region have high mtDNA variability and sequence polymorphism and therefore the ancestral camel D-Loop might have been from that region of continental Africa. All the activities related to camel rearing for a different purpose (milk, meat, and draft) and their distinct features in different pastoral communities may indicate that camel keeping in Ethiopia has been many centuries-old traditions. Moreover, the camel paintings, fossils in different rock shelters, and the high genetic diversity indicate that Ethiopia is one of the origins of camel domestication. The result of the study of husbandry and breeding practices of camel show that female camel populations with the age of  $>1$  (greater than one) year represents 78-83 % of the total camel herd in all the study districts. A higher number of female animals in the herd in the arid environment means providing a continuous supply of milk and allowing a rapid recovery of herd numbers after a disease outbreak or drought occurrence. This shows that pastoralists breeding objectives might have been associated with the arid environmental hazards and female population in the herd. Most of the pastoral communities use single breeding male camel per 40-50 female camels and this will affect productivity and heterogeneity of the camel population. With regard to trait preference, all pastoral communities ranked milk yield as the first trait of



choice, except Moyale district in which adaptation trait was the primary preference. In the camel and cattle population dynamics study, all interviewed pastoralists in Jijiga, Mille, and Borena Districts have a plan to reduce cattle numbers in the herd in the future. Most of the interviewed pastoralists in Gode, Liben, Shinille, and Mille Districts favor the reduction of cattle numbers in the herd. This shows that pastoralists realize the extraordinary properties of camel to withstand the climatic stresses much better and able to provide much more milk than cattle. In general, the results showed that cattle population is decreasing from time to time, while camel population show increasing trend in arid and semi-arid areas as a result of the combined effects of pastoralist needs and the impact of climate change, which could position the indigenous cattle breed at risk in the near future. Regarding issues related to women empowerment in the study areas, there has been a variation in decision making particularly on issues like the intensity of production, breeding, camel herding, milking, marketing, and other related activities. In general, this study observed that men have a dominant role in most decision-making processes, particularly in revenue-generating activities.



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