Chapter One

Introduction

Chapter One

Introduction

The camel is the most important animal mentioned in Qur'an as a miracle of God . The animal population in the Sudan was estimated as 141.9 million heads of which 43.4 million heads of goats, 52.1 million heads of sheep, 41.8 million heads of cattle and 4.6 million heads of camels (MARF, 2010).

Sudan has a camel population of 4.6 million heads (MARF, 2010). This population is quite important while the camel production appears, at least officially, very low. With a meat production of 49,880 tons and a milk production of 120,000 tons, camel production is far away from the potential. (Faye et al, 2011).

With a growing of increase of importance of medicinal and nutritional values of camel milk worldwide, there is an urgent need to exploit camel potentials, as it is an adapted animal to harsh conditions (Amasaib *et al* 2013).

The actual camel milk production in Sudan is estimated to be 59.000 tons per year (MARF. 2010). But the potential of camel milk production in Sudan is estimated to be 1,700,000 tons per year. There is a huge gap between actual milk production and the expected potential (1,641,000 tons milk). This could be attribute to social, nutritional, health, labor, capital and lack of governmental policies constraints.

It has been documented that camels can produce more milk and for longer period of time than any other species in harsh environment (Farah and Younas, 2005). Following the dairy cattle, water buffalo, goat and sheep, camels are the 5th most important dairy animals in the world.The species provides app. 0.3% of the globally produced milk (1.7 million tons) (Nagy and Juhanz, 2013), but some

regions like in the horn of Africa, 10% of the milk is coming from camels(Faye and konuspayeva, 2012).

Camels have the potential for milk, meat and draught power and can contribute a handsome share of the production of these commodities. The potential of this wonderful animal has never been realized and it could be harnessed as a prospective milk producing animal. The future of animals that can thrive under harsh environmental conditions, the camel being at the top of the list, is bright (Yaqoob and Nawaz, 2007).

The camels were and are still valued as riding baggage, draught animals ,hair, hides and as well as best food providers in the arid areas(Sweet,1965).several studies have shown that camels are a good source of milk and they constitute the most important source of meat in arid areas(Knoess.1977and Farah *et.al*.1992).

The population explosion, urbanization and industrialization have expanded agricultural activities to produce more food for the rapid growing human population of the country. Cultivated areas are shrinking, thus reducing the fodder production area for buffalo and cattle. Under these circumstances search must be done for other available sources to enhance milk production. The environmental changes occurring on the earth and the water shortage in the region have also adversely affected the production potential of buffalo, cattle, goats and sheep. Under these changing ecological circumstances, rearing camel is the best option for more milk production and the proper utilization of the vast unused lands (Yaqoob and Nawaz, 2007).

The camel milk provides a high amount of vitamin C to consumers in arid areas where fruits and vegetables containing vitamin C are scarce, vitamin C is in average three times higher in camel milk than that of cow milk (Farah, *et.al* 1992).

Camel milk production is stable in almost all seasons, which is very important for the pastoralist, when the milk of other animals ceases in dry periods. As the dry matter intake per kg of milk produced is much less in the camel than in other milk animals, it would be a suitable species for use even on marginal and poor grazing lands. According to some reports, the camel needs only 1.9 kg of dry matter to produce 1L of milk, compared with 9.1 kg for cows (Rollefson 2005).

Nagy et al (2007) reported that the idea of an integrated camel milk production, processing and marketing system was born in Dubai and was followed by the establishment of the world first large- scale camel milking farms. The aim of the project was to produce and market high quality camel milk and milk products from dromedaries kept under intensive management conditions.

The herders in western Sudan in the Gizu steppe land they may depend only on camel milk for more than one month (Sallam, 1999).

The udder of the she-camel like that of cattle consists of four quarters, each with its own teat. A well developed mammary system comprises one of the major component of the dairy animal score card (Mishra *et al*, 1978).Furthermore, dairy camels are characterized by the development of the udder and milk veins (Waredeh *et al*., 1990).

Camel milk is a source of livelihood and in spite of that the actual documentation of production and consumption of camel milk is entirely lacking and limited all over the world (Mehta et al, 2007).

The camel has not received much attention from researchers for that studies and information's on camel milk production are varying and very limited in the Sudan for many reasons, including a lack of awareness of its potential for milk and other products .This study is humble participation in this aspect.

Objectives of the study:

General objective:

1- To assess the productive and reproductive traits of camels as animal for milk production.

Specific objectives:

1. To study camel milk properties and nutritive value.
2. To make available Data base for future planning for research in camel milking efficiency.

Chapter Two

Literature Review

Chapter two

2. Literature review

2-1. Camels distribution in Sudan:

The one-humped camel was domesticated about (3000) years BC in Southern Arabia (Bullet, 1975), mainly for meat and milk (Epstein, 1971), for the desert dwellers (Bedouins) under extremely hostile conditions of temperature and scarcity of water and food. Camels are valued as riding, pack and work animals as well as providers of hair and hides (Bayoumi, 1990)

It is known that camel is the animal adapted to the arid lands in the old world, in Africa and in Asia. The camel population in the Sudan is concentrating between approximately isohyets 100 and 300 mm, constituting the "camel belt". This area includes the states of North and South-Darfur, North and South-Kordofan, Khartoum, Gezira, Kassala, Red Sea, River-Nile, Northern Sudan, White Nile, Blue Nile and Sinnar States. North Kordofan state has the highest camel population which is more than one million heads, representing approximately 5% of the whole world camel population. However, this population is moving and a slight expansion of the camel belt to the South has been observed since a decennial similar to that seen in other countries of Sahel region (Faye 2009).

2-2. Camel breeds:

According to El-Fadil (1986), camels in the Sudan are classified as pack (heavy) and riding (light) types according to the function they perform and probably as a result of selection applied for these traits by the various camel-owning tribes. The Sudanese heavy type constitutes the majority of the camels kept by nomads in Sudan. In this group two types can be identified on the basis of conformation and tribal ownership: The Arabi and Rashaidi camels. On the other

hand, the riding camels are restricted to the north-east of the country between the Nile and Red Sea. Two main types of the riding camel are recognized, namely Anafi and Red Sea Hills (Bishari) camels. Internationally dromedary camels were classified into four major classes named beef, dairy, dual purpose and race camel (Wardeh, 2004).

As reported by Babiker (2000), pack camels, represented by the Rshaidi Arabi camel are also named baggage camels of the Sudan. Among the Arab type, there are the baggagers of the Kordofan, Darfur and Kabashi. The Rashaidi (Zebedi) type is a short-legged, small, light animal of pinkish-red colour. It is graceful and capable of carrying moderate loads at a quick pace, though probably not as useful as the Kababish baggagers. Riding camels of the Sudan are more common in the north eastern parts of the country and include two major types, the Anafi and The Bishari pure breeds, as well as a cross between the two types (Acand, 1932).

2-3. Herd size and composition:

Camels Herd structure depends on environmental conditions and family requirement for milk, laborers and breeding animals (Gebrehiwet, 1998). AccordingtoFalah (2004), camel herders classify herds into small herds when the number of camels is less than 50, medium herds of 51-200 camels, and large herds of 201 camels and above. But it is rare to find a herd over 5000 owned by one family. the average herd size owned by one family is estimated to be about 380 camels in Saudi Arabia, 225 camels in Sudan, 310 camels in Somalia, 10-20 camels in Algeria and 80 camels in India. This generally depends on method of management, aims of raising camels. A camel herd of 100 animals is usually composed of 34 pregnant she-camels, 10 heifers of 3-4 years of age, 30 newborn

females, 3 breeding males, 20 males for fattening and 3 castrated male camels for packing and riding.

A study in the Eastern States of the Sudan (Sakr and Majid, 1998) revealed that the herd size average was about 192 heads per herd of which 38% were males, and 62% were females. Sabiel (1999) studied the Kababish camel type and he found that the average herd structure was 41% mature females, 31% males and only 5% stud bulls for natural mating.

2-4. Weighing of the camels:

Weighing is required for assessing the state of development and nutrition, to calculate precisely the drug dosage and the slaughter yield. Different methods have been used to estimate camel weight such as using a walk-on platform scale (Field, 1979)

2-5. Birth weight:

Bharagavat *et al* (1965) reported that birth weight of Bikaneri camel breed in India ranged between 26.3 kg and 52.15 kg with the pooled average of 37.23 kg, average birth weight males was 38.19 kg and that of females was 37.19 kg.

Burgemeister(1975) recorded the birth weight of Tunisian camel calves as 25.81$\pm$ 2.14 kg whereas Field (1979a) reported 30.9 kg for Rendill and Gabbra calves in Kenya. Acording to Johansson and Rendel (1968), birth weight is influenced by the many factors those contribute to the nourishment of the foetus in the utrus.

2-6. Camel housing:

According to Falah (2004), good husbandry is required to sustain and improve the health and well-being of the animal. This practice includes proper housing instable designed for all age groups of the herd to provide protection from extreme heat, cold and widely weather as well as rain. Camels should be granted good environmental and climatic conditions and adequate accommodation. Drinking water is arranged in the corners with sufficient numbers. Sufficient feed and water should be offered in a regular practice. Payne and Wilson (1999) added that for camel farms in urban a special accommodation for camels is to be designed. The type of the accommodation depends upon the use of camel.

Adequate space for each camel is essential to avoid over-crowding, the floors should allow the animal to move, lie dawn and rise easily, and the shed must be high enough. Falah (2004) noted that economic fencing should be established for extensive and intensive holding. Steel stakes are recommended since they are easy to transport and install.Generally1.2 meter high fence is enough to keep camels inside the stall.

2-7. Feed intake:

Camels are known to consume a much wider variety of plants than other domestic animals. They feed by picking up a leaf or two from one plant and moving to the next. This grazing behavior is hailed by the conservation because it reduces destruction of the environment. They can also be fed concentrate and pasture crops (Falah.2004).

Camel can browse different varieties of forages. It can efficiently utilize poor quality forage with higher crude fiber than any other herbivor does. This is done by increasing the retention time of the fiber in the fore stomach for as long as 74hours. On the other hand, if it is fed on low protein forages it can recycle and utilize its

body urea for microbial protein synthesis much more efficiently than the true ruminant (Schwartz and Dioli 1992). As the dry matter intake per kg of milk produced is much less in the camel than in other milk animals, it would be a suitable species to be used even on marginal and poor grazing lands. According to some reports, the camel needs only 1.9 kg of dry matter to produce 1L of milk, compared with 9.1 kg for cows (Rollefson 2005). The camel usually consumes 25-40 kg of good fodder per day with additional grain supplement for heavy working animals (Falah, 2004), Darling (1938) confirmed the wide variety of plants consumed by the Sudanese camel and he further noted that the camel was slow in adapting to new plants, although animals used to being handled could easily be introduced to strange forages if hand fed by the owner. Ideally camels should be allowed to feed for 6-8 hours a day, with a further 6 hours being allowed for rumination (Williamson and Payne, 1978; Matharu, 1966).

2-8. Watering of camels:

The sources of drinking water of the camel are varied. Usually animals are watered from wells dug and maintained by the herders. In desert areas during the rainy season, animals may be watered from the temporary streams, ponds or oases that develop during this time. For housed camels, piped water may occasionally be available.

Due to drinking water shortage, camel's watering frequency from once every 2 to 4 days to once every 15 days was reported by Coppock *et.al* (1988). Leese (1927) observed that while the large Delta camel of Egypt required water every day, the Somali camel could survive with only one drink in 4 days. Mares (1959) also reported the astonishing ability of Somali camels to abstain from water, concluding that they were able to go for 30 days without a drink, provided the

grazing was good. Cole (1975) noted that the Arabian camel drank once a week in the summer, every 7 to 10 days in autumn and spring and every 4 to 6 weeks in the winter. Falah (2004) mentioned that water intake rates per unit live-weight basis in dry season averaged from 29% for camels and goats to 74% for cattle.

2-9. Gestation period:

The gestation period of the dromedary is often about 1 year, with a range of 355-389 days (Williamson and Payne, 1978), while the gestation period of the Bacterian camel is slightly longer, averaging 13.5 months (Dahl and Hjort, 1976). In the Sudan camels are owned by tribes that live in the semi desert areas. All these camel types reach sexual maturity at the age of 3 - 4 years and the female gives birth once a year (Abu Sin, 1990). Mares (1954) noted that female camels tend to dry off naturally after conception, but Knoss (1976) observed a pregnant camel that was still giving a considerable amount of milk. Until it can be established whether or not the camel exhibits lactation anoeastrus, the observation cannot be relied upon as an efficient means of pregnancy diagnosis.

Field (1979a) reported that lactation ceased 4-8 weeks after pregnancy in female camels of northern Kenya. Williamson and Payne (1978) reported that some camel men work their pregnant animals up to the time of delivery and return them to work as soon after. Other camel men, however carefully look after their pregnant stock, dividing those about to deliver into a separate group which may sometimes receive extra feed and care.

2-10. Calving interval:

Falah (2004) attributed the long calving interval, once every two years, to the length of gestation, limited breeding season, late postpartum estrus and the interference of camel herders with camel breeding. He added that in well-fed camels calving interval of one year or 15 months is possible. While Schwartz and Dioli (1992) recorded calving intervals of 28.4 months in traditionally maintained herds versus 20.9 to 22.2 months in herds with both good sanitary control and nutrition. Williamson and Payne (1978) sated that calving interval in camels is prolonged not only by their limited breeding season but also their long post-partum anoestrus period. They noted that the first postpartum oestrus normally comes at about 1 year, although a few females come back into heat as early as 1 month after parturition.

2-11. Milking:

Milk let- down is induced by allowing the camel calf to suck his mother for a while and then milking by hand or machine. Sometimes the she-camels refuses to be milked or to induce milk let- down if they are not familiar with the situation or the milker (Falah, 2004). Generally camels are milked 2 to 4 times a day (Haratly, 1980) but sometimes 6 to 7 times (Knoess, 1977). Falah (2004) reported milking times to be once before dawn or just after sunrise and again at least two hours after sun set. He added that frequencies of milking of camels depend on the customs of the tribe; some tribes milk their camels once a day. He further added that Affair tribes in Ethiopia sometimes milk their camels six times a day and at other times they may leave them the whole day without milking. This practice is expected to hinder milk production in camels. In Kenya, Spencer (1973) reported that the Rendille tribe herders milk their camels three times in 24 hours. Two quarters of the udder are usually milked for consumption and the other two quarters are left for maintaining the calf (Ramet, 1987 and Ramet, 1994a). William and Payne (1978)

noted that for heavy milking she-camels only one quarter of the udder is left un-milked for the young during the first 3 weeks. In Somalia, calves are prevented from suckling at pasture by ligating two or more teats depending on the strength of the calf and the milking ability of the dam (Cossins, 1971). Zayeed *et al*.(1991) demonstrated that there is a great variation in udder and teat size and length in the she-camel, which may be attributed to variable factors including, camel type, lactation stage, parity number and disease.

2-12. Camel's milk productivity:

The milk productivity of camels in Sudan is low. Faye (2004) reported milk production between 820 and 2400 litres/ lactation for 12-18 months lactation. It is known that the farming management has a high impact on the expected productivity. With intensive management (better health care, adding concentrates in the diet, vitamin and mineral supplementation), the total milk production per lactation was 2633 liters in semi-intensive system *vs.* 1204 litres in traditional system (Bakheit *et al*. 2008).

In Pakistan, Aujla *et al* (1998) stated that the camel lactation period ranged between 250-270 days, daily milk yield varied from 4-12 liters/day and females were milked twice a day. Mares (1954) noted that the average daily milk yield for Somali camels was 5 kg/day. Knoess (1979) reported that the daily milk production for Saudi Arabia camels was 5 kg/day. Ismail and Al-Mutairi (1990) studied camel milk yield under traditional conditions and he found that the milk yield ranged between 6-7 kg per day and the total milk yield was 2300 kg per season. In Eritrea, Gebrehiwet, (1998) observed a daily milk yield range of 3.6-5.8 liters and a lactation period range of 12.0-16.8 months. In Kenya, Sato (1976) stated that the daily milk yield under nomadic conditions was 1.3 liters per day. In

Ethiopia, Belay and Getahun (2002) studied the mean lactation milk yield per dam in the Jijiga Site which was 200 kg with an average lactation length of 15 month. Camel milk possesses a superior keeping quality compared to cow milk, due to its high protein content that has inhibitory properties against bacteria. This makes raw camel milk a marketable commodity, even under high temperatures with very basic hygienic conditions(Yaqoob and Nawaz, 2007).

2-13. Factors affecting camel milk production:

Rania (2012) found that camel milk production was mainly affected by factors such as: camel breed, nutritional condition, stage of lactation and milking practices such as: calf suckling, milking frequencies, milking performance method and drinking water ability. Falah(2004) mentioned that there are certain factors influenced camel's milk yield and these factors included nutritional condition (quality and quantity of the forage), water availability, reproduction and health status, breeds, stage of lactation, milking frequency and presences of the calf.

2-14. The chemical composition of camel's milk:

Milk is a complex mixture of fats, proteins, carbohydrates, minerals, vitamins and miscellaneous constituents, dispersed in water (Ibrahim, 1998). According to Omer (2001), Camel's milk is generally opaque-white with sweet and sharp taste, but sometimes it tastes salty. The change in taste is caused by the type of feed and availability of drinking water. The differences among data on composition of camel milk reflect differences in breed, stage of lactation, the animal sampling and perhaps in the analytical procedure. (Gera *et al*. ,2007) noted that in migratory herds the mean milk constituents were protein (3.23±1.12g/dl), lactose (3.91±2.13g/dl), fat (3.59±0.16g/dl), chloride (185.8±9.28mg/dl) ,phosphorus (80.3±0.46 mg/dl), magnesium (8.4±0.29 mg/dl) ,calcium (110±38.47 mg/dl)

,cholesterol (9.41±0.49 mg/dl), sodium (24.60±1.17mEq/L) and potassium (28.52±2.28 mEq/L) .

2-14-1. Fat content of camel milk:

The camel milk fat has been characterized according to several approaches. Karry *et al* (2006) noted that compared with the cow milk fat globule membrane, camel milk fat globule membrane s physicochemical composition showed a poor content in proteins, and a higher content in neutral lipids and in phospholipids.

Falah (2004) reported that the fat content in camel milk varies between 2.9-5.4% of less content of short-chained fatty acid than that of buffalo and ewe milk. In the same context, Mohamed (1990) reported that fat content in camel milk varies between 2.5-5.9% with a mean of 4.6%.

Grounda (1996) observed the range of 2.6 – 5.5% as a concentration of fat in camel milk. milk fat range of 1.9 – 5.6 % was observed by Bayoumi (1990) and Elamin (1992), whereas, Qureshi (1986) observed the fat content of camel to be equal to that of cow milk. Webb *et al.* (1974) noted that variations of fat content of camel milk depend on the breed, feeding conditions and stage of location.

2-14-2. Protein content of camel milk

The protein content in camel milk was found to range from 2.0 to 5.5% (Knoess, 1977; Sawaya et al, 1984; Elamin and Wilex, 1992 and Farah, 1993). For Sudanese camel Dirar (1993) reported milk protein range of 3.3 – 4.7 %.

2-14-3. Lactose content of camel milk:

The concentration of lactose in camel milk was found to range from 2.4 to 5.3 % (Yagil and Etzion, 1980 Wilson, 1984 and Elamin, 1992) and from 4.8 to 5.8% (Falah, 2004). Omer (1996) compared lactose concentration of camel milk in some countries and he found that it was 4.4 % in Saudi Arabia, 3.2% in India and 3.5% in Pakistan. Hassan *et al*. (1987) reported that lactose concentration in milk of camel tended to increase during lactation, but Indra and Erdenebaatar (1994) observed no changes.

2-14-4. Minerals content of camel milk:

Chemical studies revealed that the ash content of milk is a complicated mixture which contains potassium, sodium, calcium, magnesium, chlorine, phosphorous and sulphur in relatively large amounts, small amounts of iron, copper, zinc, aluminum, cobalt and iodine and traces of silicon and boron are present in camel milk (Clarence *et al*., 1982).

Falah, (2004) noted that milk mineral salts are mainly chlorides, phosphates and citrates of Na, Ca and Mg. He added that the mineral content of camel milk expressed in ash ranges from 6 to .8%. The mineral content of camel milk as reported by Omer (2001) showed wide range of variation in the concentrations of the major minerals. Levels of sodium, potassium, zinc, iron, copper and manganese were higher in camel milk than those of cattle milk (Ahmed, 1988). All major minerals were higher in mature she camel milk than in humans which tempted some people to recommend it as a good nutritional source of these minerals (Gorban and Izzeldin, 1997).

In general variation of minerals of various studies suggested many genetic and environmental factors effects. However, for grazers, mineral contents appeared to be more uniform because of selective grazing and browsing on different plants

(Sawaya *et al*., 1984). Qureshi (1986) reported that the phosphorus content of camel milk is higher than that of cows, buffalo, sheep and goats, and he took this as an evident that camel milk in many aspects is superior to the milk of other domestic animals.

2-14-5. Vitamins content of camel milk:

Little information is available on the vitamin content in camel milk (Mohamed, 1990). He added that it appears that camel's milk contains less of vitamin A and E, Thiamin, riboflavin, folic acid, and pantothenic acid than cow's milk, while the contents of pyroxene and vitamin B12 are about the same. He further noted that the content of niacin and vitamin C in camel milk (25-60 mg/L) is of significant nutritional relevance in the arid areas where fruits and vegetables containing vitamin C are scarce. Thiagarajan (2001) reported that camel's milk has a high nutritive value with high quantity of vitamin C. The milk contained high levels of vitamin C and Niacin, conversely the amount of vitamin A was lower varying between 12.9/ IU/ l00g and 50.01/IU/100g (Ahmed *et al*., 1977). Sawaya et al (1984) aslo reported that the levels of Niacin and vitamin C were higher in camel's milk than in cattle's milk.

2-14-6. Water content of camel's milk:

Rania (2012) reported that the camel's milk water content of Saudi Arabia camels was 88.3%. Falah (2004) noted that the water content of milk fluctuates from 84 to 90%. He also reported that when water is freely accessible, the water content of the milk was 86%. But when water was restricted the water content of milk rose to 91%. Yagil and Etzion, (1980) demonstrated that drinking water caused an increase in water content of camel's milk and subsequent decrease in total solids, also found that when water was not available in hot summer, camels

produced milk with higher water content, sodium, potassium, phosphorus and chloride content but lower fat, protein, lactose, calcium and magnesium, contents.

2-14-7 Nutritive value of camel milk (Energy):

Camel's milk was found to contain approximately 770 calories (cal) or 293 Kilo Jole (kJ) energy per kg camel milk. About 4 kg of camel milk are sufficient to meet full caloric requirements of an adult human being and 1.8 (kg) would provide him with the entire daily protein requirements (Khanna, 1999).

2-15 Factors affecting camel milk composition:

Several factors affect milk composition, including the genetic factors, physiological factors and age (Falah, 1997) and the stage of lactation (Rania, 2012); type and standard of pasture (Gera *et al*., 2007). Mohammed and Hijrot (1993) added that the composition of milk depends on many factors, such as season of calving, lactation period, feeding conditions and water availability (Mohammed and Hijrot, 1993). knoess*et al*. (1986) and Ramet (1987) reported that seasonal fluctuation of water resource and feeding availability showed similar effects on milk composition.

2-16. Camel milk quality:

The most important property of camel's milk is that it can be kept for longer periods than cattle's milk when refrigerated and even with the desert heat it does not spoil very soon (Thiagarajan, 2001). Dukwal *et al*. (2007) found that camel milk remains quite stable at room temperature and takes a comparatively longer time to become sour.

Camel's milk is a rich source of protein with potential antimicrobial and protective activities (Wernery, 2003). He added that the most important protein is

the alfa lactoalbumin which similar to the lysozyme enzyme in inhibiting the growth of bacteria. He further added that insulin, vitamin c, niacin and some unsaturated fatty acids are higher in camel's milk than that of cattle. Dukwal et al. (2007) also observed that protein and carbohydrate contents of camel's milk were significantly higher as compared to cattle's milk.

2-17. Camel milk products and their uses:

Nowadays, camel milk production is in progress in many countries in both Asia and Africa due to the increased demand (El-Agamy, 2006). New technologies were introduced to produce high quality camel's milk products (Joshi et al, 2007, Wernery, 2007). According to Knoess *et al*. (1986) and Qureshi (1986), products made from camel's milk include sour milk, cheese, butter and ghee. Despite common belief in south Asia that camel's milk cannot be used to prepare butter and ghee due to the small diameter of fat globules, some local and foreign workers have devised methods to make butter and ghee successfully. The camel's milk in the Sudan is consumed fresh or fermented (*gariss*) that had been mainly processed under traditional manner (Faye *et al*., 2011). Iin north-eastern Baluchistan, Qureshi (1986) noted that the most common products made from camel's milk are *dahi* (yoghurt), lassi (sour milk) and *kurth* (cheese). He added that there was a general belief that butter could not be made out of camel milk, but the Livestock and Dairy Development Department Punjab obtained 175g butter from 4L camel's milk. The detailed procedure has been described by Raziq and Younas (2006).

Low heat (LH) and high heat (HH) camels' milk powders were manufactured from fresh camel's milk (Abu-Lehia, 1994). As a result of using low drying and outlet temperatures, the moisture content of LH powder (3.32%) is higher than that of HH camels skimmed milk powder (Falah, 2004).

Pasteurized milk and other dairy products made from camel's milk are available in the markets in Gulf area and Mauritania (El-Agamy, 2006). Wernery *et al*. (2003) indicated that pasteurization at 72º C for 5 minutes revealed no change in camel milk composition. Abeiderrahman (1997) noted that pasteurization at 72^0 c for 15 was inadequate, but by pasteurizing at 80^0 C for 20 seconds the bacterial counts dropped to the best European standard levels, provided extreme hygiene is observed; milk flavor was not badly affected by this heat treatment.

Fermented products of camel's milk have different names in various parts of the world (Aggrawalda and Sharma, 1961). It is called Kefir in the Caucasus, motzoon in America, yoghurt in India and Bulgaria, Lehben in Syria and Egypt and Garris in the Sudan (Abdelgadir *et al*., 1998).

In the Sudan "Gariss" is a special kind of fermented camel milk prepared solely under more or less continues shaking (Dirar, 1993). The product is prepared and consumed by camel herders commonly in eastern Sudan (Elagab and Elfaki, 2000).Sulieman *et al*. (2006) investigated some of the chemical and microbiological characteristics of "Gariss". They found that lactic acid bacteria (LAB) dominated the microflora of "Gariss" samples and the major genera were *lactobacillus* (74%), followed by *lactococcus* (12%), *Enterococcus* (10%) and *lenconostucs* (4%). El-Hofi and El-Tanboly (2006) used pasteurization for improving the keeping quality of yoghurt manufactured from camel's milk using heat shock treatment (60ºC for 2.5 minutes).

Bayoumi (1990) stated that camel's milk is difficult to coagulate by rennet and it is less suited for cheese manufacturing compared to milk of cattle, goat or buffalo.Pant and Chandro (1980) reported that manufactured casein can be made

from camel's milk but not for human consumption and could be used as a glue and gum.

Farah and Fischer (2004) mentioned that it is difficult to obtain butter from camel milk because of the lack of agglutinin protein which promotes clustering of fat globules and formation of cream layer in cold milk. El-Bashir (1997) reported that butter can be produced after shaking the camel milk for 15 – 20 minutes or 3 - 4 hours at 24 - 25ºC. He also stated that it was difficult to keep butter fresh and for that it was heated at 100 – 120ºC for 30 minutes to be converted it into "Ghee". Izzaddin (2002) noted that butter from camel's milk contains higher percentage of non-saturated fatty acids than those from cattle's milk. He added that butter of camel's milk has unaccepted taste therefore it is used mainly for cooking and cosmetics.

El-Bashir (1997) reported that *Al-Khawa* is a sweet product from camel milk after evaporating at high temperature with continuous moving of the milk until it becomes semi-solid. It is, then sweeted and can be kept for (200) days. Abeiderrahman (1997) reported that in Muritania sweetened camel's milk produced to be drunk directly.

According to Rania (2012), camel's milk ice cream had been launched first in the United Arab Emirates (UAE) at Al-Ain. The product was healthy and could be an alternative to other ice cream products. Camel's milk ice cream was found to contain only 2.5% fat, compared to that between 6 to 9 % for standard ice cream. In addition, it is safe for consumers with lactose intolerance and contained three times more vitamin C than cattle milk ice cream.

2-18. Medical prosperities and uses of camel milk:

Camel's milk is used in some parts of the world as cure for certain diseases. Knoess (1982) metioned that in India camel's milk had been used as a therapy for dropsy, Jaundice, problems of the spleen, tuberculosis, asthma, anaemia and piles. Wernery (2003) reported that recent data suggested that camel's milk contained medicinal properties to treat different ailments such as Auto Immune Disease, Juvenile diabetes, booster of immune system, stress, peptic ulcers and skin cancer. , Yagil (1982) added that chronic hepatitis was often being treated with camel's milk because it was found to improve liver function. Camel's milk was also given to sick elderly and very young people because it is believed to work especially well in bone formation (Yasin and Walid, 1957).

Yagil (1982) noted that the belief among the Bedouins of the Sinai Peninsula was that an internal disease could be cured by drinking camel's milk. He also reported that the milk is believed to be of such strength and to have such health properties that all the bacteria are driven out of the body; however, this belief is only for camels that eat certain shrubs and bushes. Benkerroum *et al*. (2004) found that the camel's milk and colostrum samples had bacteriostatic effect against the pathogenic strains of *Escherichia coli* and *Listeria monocytogenes*. Rania (2012) reported that in the Sudan, fermented camel's milk is used to cure *Leishmaniasis* or Kalazar. The patient had to live on "Gariss" alone as food for a long perion after which it was claimed that he would be fully cured. Agrawel *et al*. (2005) mentioned the utilization of camel's milk for people with type A diabetes. Khalifa (2007) reported that camel's milk can be used for treatment of diabetes and high cholesterol patients.

Chapter Three

Materials & Methods

Chapter three

3. Materials and Methods

3.1: Survey in Khartoum camel farms:

The survey in camels farms was conducted in Khartoum State between January and February-2010 this was done through a questionnaire in eleven camel farms. Nine farms in Khartoum North and two farms in Omdorman.The questionnaire (Apn.1) provided information about (farms, herd owners, herds, herd men, milking, nutrition, watering, housing and marketing).

3.2: Study area:

The study was conducted in Khartoum North into two farms of similar system of management and have late stage pregnant she camels of different parity orders. The first farm (Major Dr. Alaas) (Plate1) wich located at Alkadaro, the second farm (Major. Mahjoub) (plate2) wich located at Alizba.

3.3: Experimental Animals:

The survived farms showed 131 lactating she camels, 132 dry she camels, 131 young females, 72 young males, 8 heifers, 7 adult males and 11 breeder males. Seventeen individual camel (*Camelus dromedaries*) milk samples, representing lactation period after 5 days after parturition, were obtained from 2 farms at El-Alaas Farm and Mahgoob Farm.

3.3.1: Identification:

Each of the selected females was identified by a plastic tag with a numerical number placed around the neck. A record was made for each animal containing: parity order, calving date(plate 3), calving birth weight, she-camels monthly weigh by measuring the chest girth in cm and daily milk yield.

3.3.2: Parity order and date of calving:

Were offered by the herd men, who were very knowledgeable about these parameters.

3.4: Milk sampling and collection:

One hundred and eighty one samples were collected from seventeen individual she-camels in clean plastic containers (50 ml) (plate.3), each Container was given the number of the animal(plate 4).The samples were stored in an insulated container using freeze packs. All milk samples were transferred to (Shambat)(Khartoum university).

3.5: Daily milk yield:

Daily milk yield was measured by weighting everyshe-camel twice daily milk by hanging kettle at the scale in kg.

3.6: Calves birth weight:

This method was done by hanging the scale at the sack then hanging the calve after entering it in metal bar(plate 5).

3.7: Body Weight Estimation of the she-camel:

The measurement was taken by metric tape.The chest girth measurement was taken when the she-camel was standing.The tape was encircled around the chest of the she-camel, posterior to the in fore legs(plate 6).

Estimation of body weight were calculated according to Wilson (1984): formula for linear regression of chest girth

Y= 5.071X – 457

Where: Y= body weight in kg.

X= Animal chest girth in cm.

3.8: Milk yield determinations:

Calves were allowed to suckle their dams to stimulate milk secretion, until the milk start to flow and then the calves were removed(plate 7). The milking was done standing twice per day. The milker stands on the udder the milking process is done in standing position with one knee raised to support the kettle. The milker stands on one leg and balancing the kettle on his leg and uses both hands for milking. milkers used stranded and hold the kettle by his left hand and use the right hand to evacuate the udder.The milk yield per she camel obtained by hanging kettle at the scale in kg.

3.9:Milk composition determinations:

A represented sample from individual she-camel was collected (30 ml). And each sample was given the number of the animal. The samples were stored in an insulated container using freeze packs. All milk samples were transferred for milk analysis in (Khartoum University, Faculty of Animal Production, Shambat).

3.9.1: Determination of protein:

The method used to calculate Nitrogen was Micro Kjeldahl method (AOAC, 1990).

Ten ml of milk sample were weighted and added to the flask. Two tablets of catalyst (Kjel tabs: each tablet containing 1 g of magnisium sulphate (K_2SO_4) and equeivalent of 0.1 mg Hg) were added to kjedahl digestion flask, 25ml of sulfuric

acid (H_2SO_4) (density: 1.86 mg/ml at 20^{o}C) were put in the flask. The mixture was digested on a heater for (2.5) hours until a clean solution was obtained.The flask was left to cool room temperature, and then contents were diluted to 100 ml by distilled water. Five ml of the digested sample was taken and transferred to distillation unit, the distillate was collected in a flask containing 25 ml 2% Boric acid and 3 drops of (bromocerol green plus methyle red). The distillate was continued until the volum was 75ml. the flask removed from the distillatory. The distillate was titrated against 0.1 N H_2SO_4 to (red color).

Calculation:

$$\text{Nitrogen (\%)} = \frac{T \times 0.1 \times 0.014 \times 20}{W.S} \times 100$$

Protein (%) = Nitrogen (%) X 6.25

Where:

T = Titrant volume.

0.1 = Normality of Hcl.

0.014 = Atomic weight of Nitrogen 2/1000.

20 = Dilution factor.

W.S = Weight of sample.

3.9.2: Determination of Fat:

Fat content was determined using Gerber method (AOAC, 1990).

Ten ml of sulfuric acid (specific gravity 1.815gm/ml at 20°C) were transferred to Gerber. Ten ml of sample were added carefully. Then one ml of amyl alcohol (sp.g. 0.814) was added, then was shaken until no white particles were seen. Centrifuged at 1100revolution / minute and transferred to a 65°C for 3 minutes.

The fat columns of the fat were then recorded.

3.9.3: Determination of Lactose:

Lactose content was determinate using Anthrone method

One ml of milkwas taken with apipette and diluted in 500 ml of distilled water. 0.5 ml by pipette of the solution was transferred to boiling tube.10 ml of anthrone reagent added to the 0.5 boiling tube. 0.5 ml of distilled water placed in boiling water for six minutes then transferred to an ice- bath for 30 minutes.

Calculation:

$$\text{Lactose content (g/1000ml)} = \frac{\text{O.D. of sample} - \text{O.D. of blank}}{\text{O.D. of standard} - \text{O.D. of blank}} \times 4.75$$

3.9.4: Determination of moisture and total solids:

Total solids content was determined by forced Draft oven method (Marshall, 1993).

Clean dishes were heated a like in an oven for 1 hour at 105°C. Then they were transferred and stored in clean desiccators to cool. Three grams of milk sample was weighed accurately into each dish. The dishes were heated in the oven for 3 hours at 105°C. After that they were transferred to desiccators with lid on, and allowed to cool at room temperature then the dishes were weighed.

Calculations:

$$\text{Moisture (\%)} = \frac{W1 - W2}{W1} \times 100$$

$$\text{Total solids (\%)} = \frac{W2}{W1} \times 100$$

Where: W1 = Weight of the sample before drying.

W2 = Weight of the sample after drying.

3.9.5: Determination ash content:

A clean crucible was heated for one hour, then cooled and weighed. 2 ml of milk sample were weighed with crucible and placed in a furnace (500°C) and left to (incinerate) overnight .The crucible transferred to desiccators to cool at room temperature and weighed.

Calculations:

$$\text{Ash\%} = \frac{\text{weight of residue}}{\text{weight of sample}} \times 100$$

Fresh water was available all time. All the animals were under the farm veterinary observation and were in good health.

3.9.5.1: Determination of sodium (Na):

Ash extracted of the milk sample was prepared by adding 10 ml Hcl (28% conc.) to the sample in a clean dish.The solution was put for 10 minutes in a water bath then filtrated and completed to 100 ml and the samples were prepared by adding 9.9 ml distilled water to 0.01 ml of sample.The flame photometer was prepared by adjusting the fuel to obtain clear blue flame and read deionized water to adjust the instrument to zero and the samples were read in the flame photometer (F.F.S.R, 1976).

3.9.5.2: Determination of potassium (K):

Ash extracted of the milk sample was prepared by adding 10 ml Hcl (28% conc.) to the sample in a clean dish.The solution was put for 10 minutes in a water bath then filtrated and completed to 100 ml and the samples were prepared by adding 9.9 ml distilled water to 0.01 ml of sample.The flame photometer was prepared by adjusting the fuel to obtain clear blue flame and read deionized water to adjust the instrument to zero and the samples were read in the flame photometer (F.F.S.R, 1976).

3.9.5.3: Determination of phosphorus (P):

Phosphorous was determined by atomic absorption spectrophotometer method described by Hanson (1950).

One gm of milk was ashed, then 10 ml of HCl (28% conc.) were added, then the mixture was placed in a sand bath for one hour. It was filtrated in 100 ml flask and completed to 100 ml with deionized water. 15 ml of the mixture were transferred to a 25 ml volumetric flask, and then 10 ml of ammonium molybdate were added to the flask. For the preparation of the standard curve 2, 4, 6, 8, 10 and 12 ml of phosphorus standard solution (50 mg p/m) were placed in series of 25 ml volumetric flasks, then 10 ml of ammonium molybdate were added to each one of the flasks and all flasks were completed to 25 ml with deionized water. The blank solution was prepared by diluting 10 ml of ammonium molybdate to 25 ml with deionized water.

The results were obtained by using atomic absorption spectrophotometer at 440 nm by which the standard curve was prepared (phosphorous concentration on the X-axis and the absorbance on Y-axis). Then the samples concentrations were read from the graph.

Calculation:

$$P\ (mg/g) = \frac{\text{Sample concentration} \times \text{Dilution Factor}}{\text{Sample weight}}$$

3.9.5.4: Determination of calcium (Ca):

Calcium was determined by atomic absorption spectrophotometer method described by Hanson (1950).

One gm of milk was ashed, and then 10 ml Hcl (28% conc.) were added. After that, the mixture was placed in a sand-bath for one hour, then It was filtrated in 100 ml flask and completed to 100 ml with deionized water. Thereafter, 15 ml of the mixture were transferred to a 25 ml volumetric flask then 10 ml of La Cl_3 10% solution were added to the flasks for the preparation of the standard curve 2, 4, 6, 8, 10 and 12 ml of Ca^{+2} standard solution were placed in series of 25 ml volumetric flasks, then 10 ml of La Cl_3 10% were added to each one of the flasks and all flasks were completed to 25 ml with deionized water.

The results were obtained by using atomic absorption spectrophotometer at 420 nm. Standard curve was drawn (Calcium concentration on the Y-axis and the absorbance on the Y-axis). Then the sample concentration was read from the graph

Calculation:

$$Ca\ (mg/g) = \frac{\text{Sample concentration} \times \text{Dilution Factor}}{\text{Sample weight}}$$

3.10: Statistical analysis:

Using StatSoft, Inc. (2011) STATISTICA (data analysis software system) version 10 to analyse the data.Percentage for description of the questionnaire. Taking the farm and the period from day of start of the experiment to day of calving as covariates, the data were subjected to analysis of covariance to test the significance of effect of camel's type on she- camel milk production traits as well as the lactation curve. Matrix of coefficients of correlations of lactation performance traits and lactation curve components ofBushari,Arabi and Anafi. Matrix of coefficients of correlations of lactation performance and milk composition traits of Bushari, Arabi and Anafi breeds.

.

Chapter Four

Results

Chapter four

4. Results

4.1: Analysis of the survey data:

The results of the direct questionnaire are shown in figures from 1 to 11 and tables from 1 to 12.

4.1.1: The farm:

4.1.1.1: The distribution of camel farms in Khartoum State:

The survey of the eleven farms in Khartoum State showed that 81.8% of camel farms were located in Khartoum North and 18.2% in Omdurman (Fig.1).

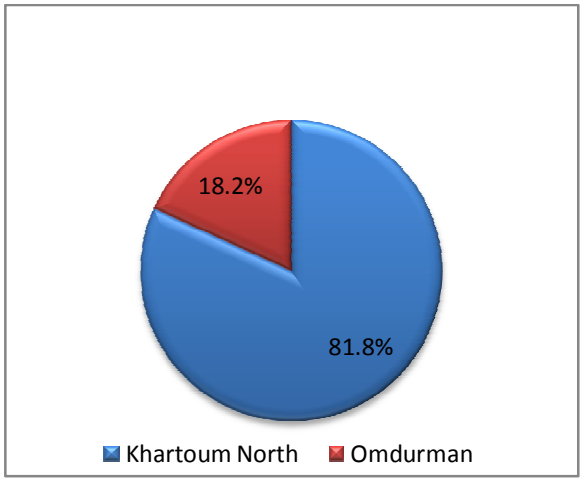

Figure1: Distributions of the studied camel farms in Khartoum State.

4.1.1.2: The herding types in the visited camel farms:

The frequencies for herding camels only and camel with cattle were similar in each 4 farms (36.4%), all types of animals (camel, cattle,and goat) were found in 3 farms (27.2%) (Table1).

Table1: Herding type.

Herding type	No. of farms	Percent
Camel only	4	36.4
Camel and Cattle	4	36.4
Camel and others	3	27.2
Total	11	100

4.1.1.3: The purpose of keeping animals:

High frequency was found for the purpose of farm investment in milk production 9 farms at (81.8%), for milk and meat were only in 2 farms at (18.2%). (Fig.2).

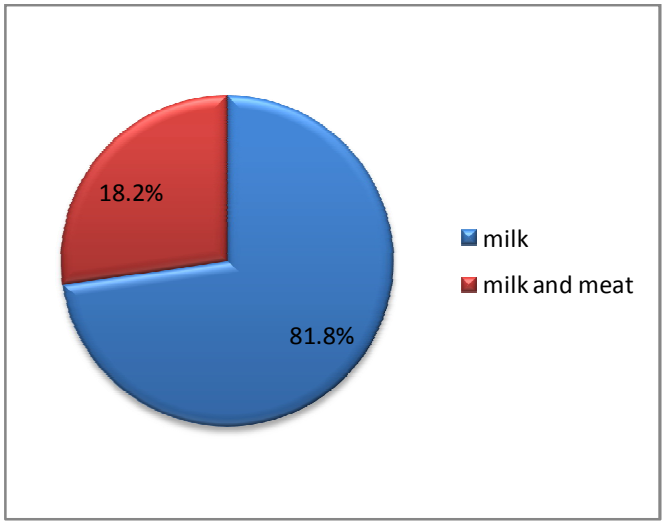

Figure2: Purposeof keeping camel.

4.1.2: Owners:

All owners of the eleven camel farms were above 40 years old.

4.1.2.1:The owner education:

Camel owners in 4 farms (36.3%) were non-educated while secondary education was the least frequency in one farm (9.1%). (Fig.3)

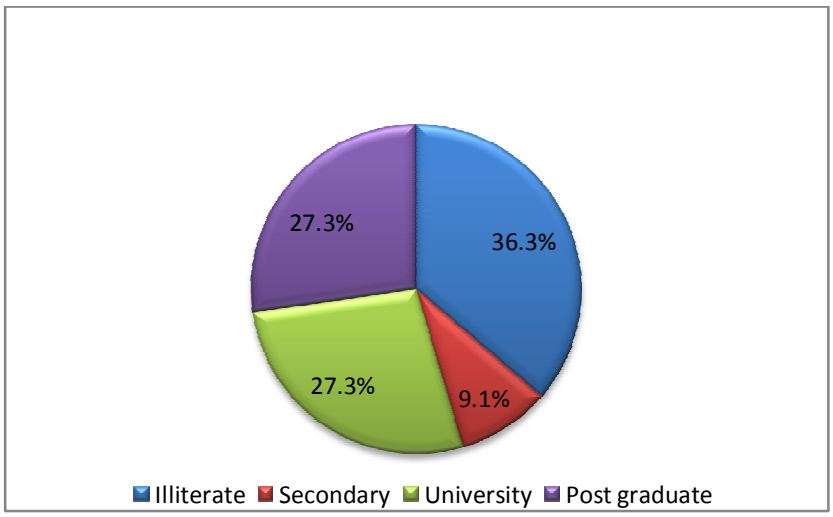

Figure3: Camel owner education.

4.1.2.2: The relationship of camel owners with animals:

Professionals were the majority of owners in 7 farms at (63.6%), investor in 3 farms (27.3%) and the amateur in 1 farm (9.1%). (Fig.4).

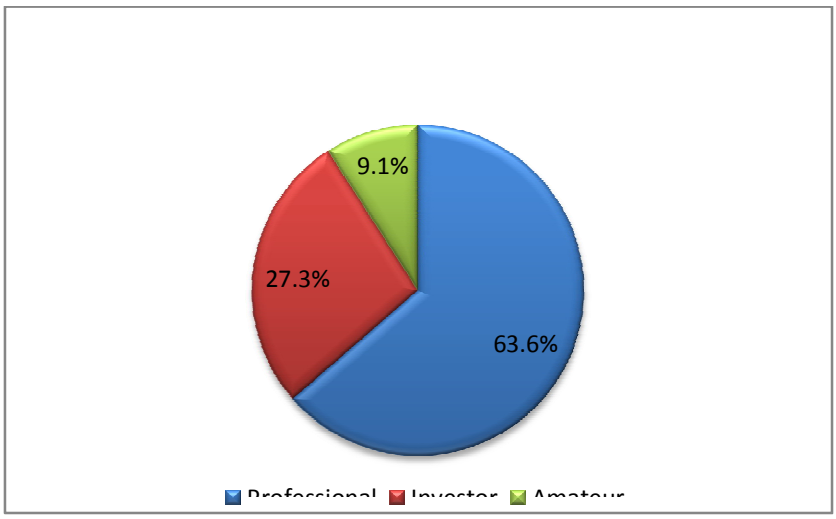

Figure4: Relationship of camel owners with animals

4.1.3: Herd men:

The study found that all herds' men were employed as herders and milkers on fixed payment.

4.1.3.1: Herdmen number in the camel farm:

The herds men from 1 to 5 represented the higher frequency in 10farms at (91%) and only one farm had more than 5 herdsmen at (9%). (Fig.5).

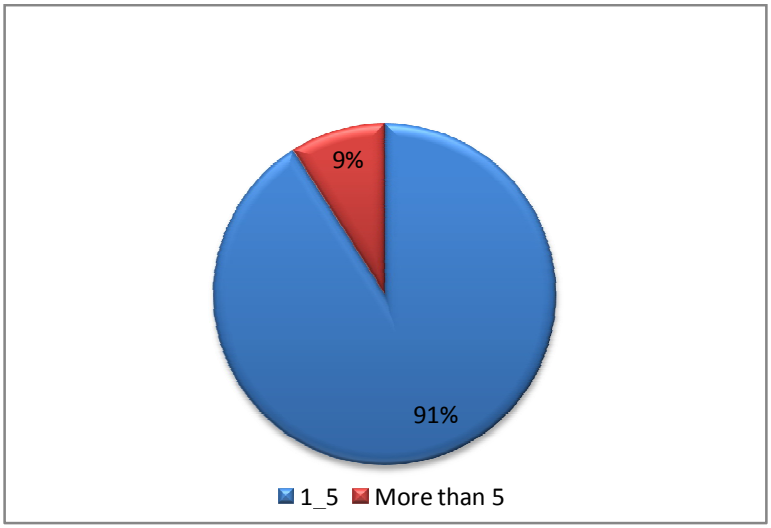

Figure5: Herd men number in the 11 camel farms.

4.1.3.2: Level of education of Herd men:

Number of Educated herd men was higher than alliterates ones in 6 and 5 farms at (55%) to (45%) rates respectively. (Fig.6).

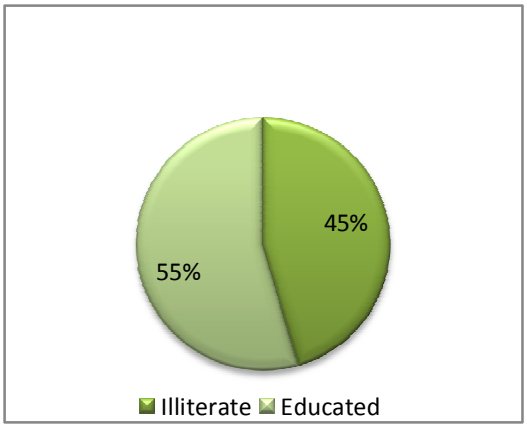

Figure6: level of education of Herd men in the 11camel farms.

4.1.4: The Herd:

4.1.4.1: Camel type:

The collected datashowed that the common camel type was pack camel in 6 farms (55%) then both pack and riding camels in 4 farms (36%) and riding camels in one farm (9%). (Fig.7).

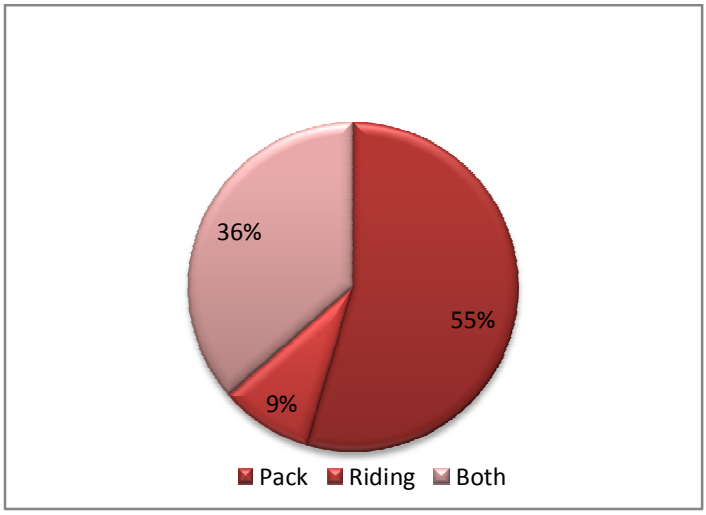

Figure7: Camel type in the investigated 11 camel farm.

4.1.4.2: Percentage of camel breed ecotypes kept in study sample in Khartoum state:

During the study period seven camel breed eco-types were detected in 11 camel farms in Khartoum State .Arabi and Bushari ecotypes represented 56% of the ecotypes kept in Khartoum State, while Shukrii ecotype wasthe least frequent ones. (Table 2)

Table 2: Percentage of camel breed ecotypes kept in the studied camel farms in Khartoum state.

Camel breeds	No. of farms	Percent
Arabi	8	32
Bushari	6	24
Rashaidi	3	12
Anafi	2	8
Kabashi	2	8
Kinani	3	12
Shukrii	1	4
Total	25	100

4.1.4.3: Herd size:

The herd size ranged from 12 up to 216 camel, the most frequent herd size was from11to 20 camels which was found in 4 farms (36.4%) followed by the herd size from 31 to 40 camels in 3 farms (27.2%) then 21-30 camel in 2 farms (18.2%), those farms with 51-60 and more than 100 camels were found (9.1%) for each one. (Table 3).

Table 3: Herd size in 11 camel farms in Khartoum State.

Herd size	No. of farms	Percent
11-20	4	36.4
21-30	2	18. 2
31-40	3	27.2
51-60	1	9. 1
More than 100	1	9.1
Total	11	100

4.1.5: Nutrition:

Table 4,5,6 showed that all the 11surveyed farms were found to supplement their camels with concentrates. About 73% of the farms used green fodder while the rest fed their animals on pastures + concentrates or fed concentrates only (Table 4). Abu70 and berseem were the most common used green fodder (Table 4)

4.1.5.1: Type of feeding:

Table 4: Type of feeding of camel in 11 farms in Khartoum State

Type of feeding	**No. of farms**	**Percent**
Pasture and green fodder+ concentrates	5	45. 5
Green fodder and concentrates	3	27.2
Concentrates	2	18. 2
Pasture +concentrates	1	9. 1
Total	11	100

4.1.5.2: Green fodder in pasture:

Table 5: Green fodder in pasture available for investigated camel.

Green fodder	**No. of farms**	**Percent(%)**
Abu 70	4	36. 4
Abu 70+ berseam	3	27.2
Berseam	1	9. 1
B.a+A.s++A.n	1	9. 1
Total	9	٨١.٨

B.a= *Balanites aegyptiaca*

A.s= *Acacia seyal*.

A.n= *Acacia nilotica*.

4.1.5.3: Concentrates:

Table 6: Type ofConcentrates supplement given to the camel.

Concentrates	No. of farms	Percent (%)
Cotton seed cake+ brane	4	36.3
Gandul	2	18. 2
Sorghum+brae	2	18. 2
Gandul+cotton cake+ brane	2	18. 2
Sorghum+ground nut cake	1	9. 1
Total	11	100

4.1.6: Watering system:

4.1.6.1: Water Sources:

Six farms in this study depended on national water net as a sources of water followed by the use of wells in 4 farms (36.4%), while watering from canals represented the less frequency only in one farm (9.1%). (Fig.8)

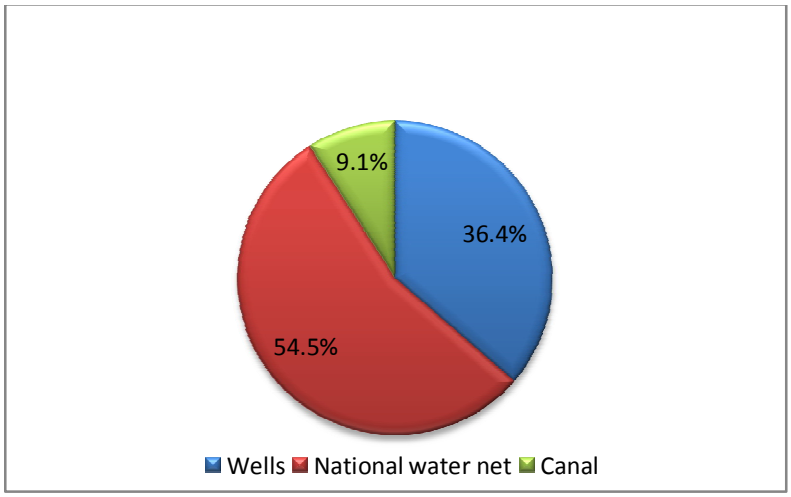

Figure8: Water sources used by the camel in Khartoum State.

4.1.6.2: Additives to water:

Most farms were found to use water as it is, 36.4% water with added in 4 farms added bicarbonates and salt , only one farm (9.1%) added Molas .(Table 7)

Table 7: Additives to water

Additives to water	No. of farms	Percent
No additives	6	54.5
Biocarbonates	2	١٨.٢
Common salt	1	٩.١
Common salt and biocarbonates	1	٩.١
Molas	1	٩.١
Total	11	100

4.1.7: Milking:

All milking let down stimulation in the 11 farms was through the presences of the offspring and each she-camel was milked by one milker.

4.1.7.1: Milking frequency:

Concerning the milking frequency high frequency in 9 farms was (81.8%) for she camels milked twice followed by both three and four times at (9.1%). (Table 8).

Table 8: Milking Frequency of she-camel in the eleven farms.

Milking frequency	Count	Percent
Twice	9	81.8
More than two	2	18.2
Total	11	100

4.1.7.2: Udder milking:

Five farms (45.5%) milked the entire udder followed by milking half of the udder in 4 farms (36%) and three quarters in 2 farms (36%), (18.2%). (Fig.9).

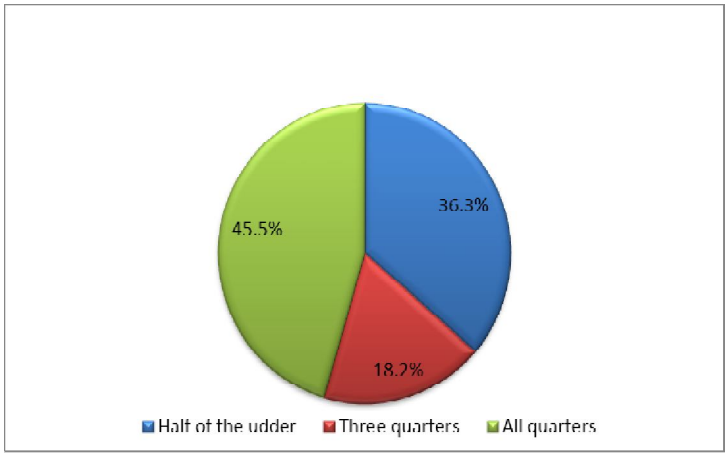

Figure9: Udder milking in 11 camel farms**.**

High frequency average daily milk yield/she-camel was recorded 4 kg/day in 5 farms (54.5%).The lower milk yield was recorded as 2kg/ she-camel in 2 farms(27.3%) (Table 9). On the other hand the average daily total milk yield/farm was found in 5 farms as 80 kg (54.4%) while the lowest milk yield/farm was recorded in 3 farms (27.3%) (Table 10).

4.1.7.3: Average daily milk yield/she-camel:

Table 9: Average daily milk yield/she-camel

Daily milk yield Kg/she-camel	No. of farms	Percent
2	3	27.3
3	1	9.1
4	5	54.4
5	1	9.1
6	1	9.1
Total	11	100

4.1.7.4: Average daily total milk yield/farm:

Table 10: Average daily total milk yield/farm in the 11 camel farms.

Daily milk yield / Kg / farm	No.of farms	Percent
20-40	3	27.3
41-60	2	18.2
61-80	1	٩.١
More than 80	5	45.4
Total	11	100

4.1.7.5: Lactation period:

The high frequency for lactation period was more than12 moths it was recorded in 6 farms (54.5%), the lowest lactation period which was equal or less than 8 months was recorded in 3 farms (27.3%). (Table 11).

Table 11: Lactation period in the eleven camel farms investigated.

Lactation period (month)	No. of farms	Percent
≤8	3	27.3
10	2	١٨.٢
12 or more	6	54.5
Total	11	100

4.1.7.6: Milk products:

The camel milk was found to be processed to Gariss in 7 farms (63.6%) and to ice cream in one farm (9.1%). (Table 12).

Table 12: Number and percentage of farms that produced different product from camel milk.

Milk products	No. of farms	Percent (%)
Gariss	7	63.6
Non processed milk	3	٢٧.٣
Ice cream	1	٩.١
Total	11	100

4.1.8: Milk marketing place:

4.1.8.1:Milk marketing:

Milk marketing at the farm gate was the most frequent and reported in 6 farm (54.5%) then selling in the farm plus marketing centers in 3 farms (27.3%) and that used by the families in 2 farms (18.2%). (Table 13).

Table 13: Milk marketing

Milk marketing	No. of farms	Percent (%)
In the farm	6	54.5
In the farm+ marketing centers	3	٢٧.٣
Used by families	2	١٨.٢
Total	11	100

4.1.8. 2:Milk price and total selling revenue:

6.8 Sudanese pound / Kg camel milk was the most frequent price in 5 farms (45.4%), which the other prices included 4.5 and 5.6 Sudanese pound/kg each in two farms (18.2%). The total revenue ranged from 0.972 up to 30.912 thousand Sudanese pounds. The total revenue ranged from 0 to 2 thousand Sudanese pounds in one farms (11.1%), 2-4 thousand Sudanese pounds in 3 farms (33.3%) and 4-6 thousand Sudanese pounds in 4 farms (44.5%). (Table 14).

Table 14: Milk price and total selling revenue in 9 farms.

Milk price (Sudanese pound)/Kg	**No. of farms**	**Percent (%)**	**Total revenue (thousand SD)**	**No. of farms**	**Percent**
4.5	2	18.2	0-2	1	11.1
5.6	2	18.2	2-4	3	33.3
6.8	5	45.4	4-6	4	44.5
Total	9	81.8	More than 6	1	١١.١
			Total	9	100

4.2: Milk production of Bushari, Arabi and Anafi she-camels:

4.2.1: Descriptive statistics of milk production traits:

Table (15) showed the means and standard error of the milk production traits and lactation curve parameters. The milk production traits included the total milk yield, lactation period, and peak yield and milk yield persistency also included ooffspring weight, calving weight, and lactation end weight and total lactation body change.

Table 15: Descriptive statistics of milk production traits of Bushari, Arabi and Anafi she-camels.

Trait	**Means (±SE)**
Total yield, kg	1932± 360
Lactation period (weeks)	53.3± 7.48
Observed peak yield (kg/week)	59.2± 7.19
Persistency of yield (%)	66.8± 5.03
Offspring weight (Kg)	35.2± 2.42
Offspring weight (%)	7.2± 0.520
Calving weight (kg)	490± 15.6
Lactation end weight (kg)	481.3± 19.2
Total lactation body change (kg)	-8.8± 13.5

4.2.2: Milk production traits of the Bushari,Arabi and Anafi breeds:

The milk production performance of the studied Bushari, Arabi and Anafi she-camels is shown in (Table 16). There was no significant differences ($p>0.05$) between the three she camels of the in total milk yield, lactation period, offspring weight, offspring weight%, calving weight and lactation end weight. For peak

yield, the Bushari and Arabi she camels produced the same amount that was significantly higher than that produced by the Anafi she camel. However Bushari she camel had significantly higher yield persistency than the other two she camels which they were similar. For the total lactation body change Bushari and Arabi were significantly higher than Anafi.

Table 16: Milk production traits of the Bushari,Arabi and Anafi breeds

Milk Traits	Breeds			SE	p		Overall mean	Std.Dev.
	Bushari	Arabi	Anafi					
Number of observations	6	6	5					
Total yield, kg	2368.82	2053.95	1262.86	359.568	0.133	NS	1932.4	954.65
Lactation period, weeks	44.43	56.51	47.67	7.481	0.497	NS	49.6	16.88
observed peak yield, kg/week	72.88^{a}	58.23^{ab}	44.05^{b}	7.193	0.048	S*	59.21	22.20
persistency of yield, %	79.07^{a}	60.17^{b}	59.96^{b}	5.027	0.026	S*	66.8	14.37
0ffspring weight	33.33	36.25	36.10	2.423	0.631	NS	35.2	6.88
offspring weight% of dam weight	7.04	7.33	7.19	0.520	0.922	NS	7.2	1.20
calving weight	473.36	496.13	502.88	15.560	0.398	NS	490.1	46.56
lactation end weight	481.85	498.05	460.40	19.175	0.418	NS	481.3	49.88
total lactation body change, kg	7.58^{a}	2.08^{a}	-41.58^{b}	13.504	0.046	S*	-8.8	37.11

NS= Not significant ($P > 0.05$).

S*= Significant ($P > 0.05$).

a, b: means in the same row with different superscripts are significantly ($P > 0.05$) different.

wt= weight.

4.2.3: Descriptive statistics of lactation curve parameters of Bushari,Arabi and Anafi she-camel:

Table (17) shows the lactation curve parameters which included yield at the beginning of lactation (constant a), the ascending (constant b) and the descending (constant b) slopes of the lactation curve, the estimated week of peak and weekly peak yield and persistency of lactation curve.

Table 17: Descriptive statistics of lactation curve parameters of Bushari,Arabi and Anafi she-camel.

Trait	**Means(±SE)**
a	45.4± 7.27
b	0.304± 0.100
c	0.038± 0.007
Week of peak	7.6± 1.39
Peak yield, kg/week	63.5± 7.98
Persistency of lactation curve, weeks	4.6± 0.466

a = Representing yield at the beginning of lactation.

b = The factor associated with ascending slope of the lactation curve.

c = The factor associated with descending slope of the lactation curve.

4.2.4: Lactation curve parameters of Bushari,Arabi and Anafi breeds :

The Bushari, Arabi and Anafi she camels did not differ significantly in all of the parameters of the yield at the beginning of lactation (constant a), the ascending (constant b) ,week of peak, peak yield and persistency of lactation curve except the descending (constant c) slopes of the lactation curve whereas Arabi and Bushari were significantly higher than Anafi . (Table 18)

Table 18: Lactation curve parameters of Bushari,Arabi and Anafi breeds

Breeds	**Bushari**	**Arabi**	**Anafi**	**SE**	**p**	
Number of observations	6	6	5			
a	57.21	41.1	36.5	7.27	0.145	NS
b	0.31	0.40	0.18	0.100	0.326	NS
c	0.037^{ab}	0.052^{a}	0.021^{b}	0.007	0.019	S*
week of peak	7.71	7.28	8.06	1.388	0.950	NS
peak yield	77.6	61.5	49.2	7.96	0.079	NS
persistency of lactation curve	4.37	4.13	5.45	0.466	0.154	NS

NS= Not significant (P > 0.05).

S*= Significant (P > 0.05).

a, b: means in the same row with different superscripts are significantly (P > 0.05) different.

4.2.5: The average lactation curve of Bushari, Arabi and Anafi breeds:

Fig (10) illustrates the lactation curves of the three studied breeds. It is obvious that the curve of Bushari breed was the steepest, whereas that of Anafi camel is the flattest.

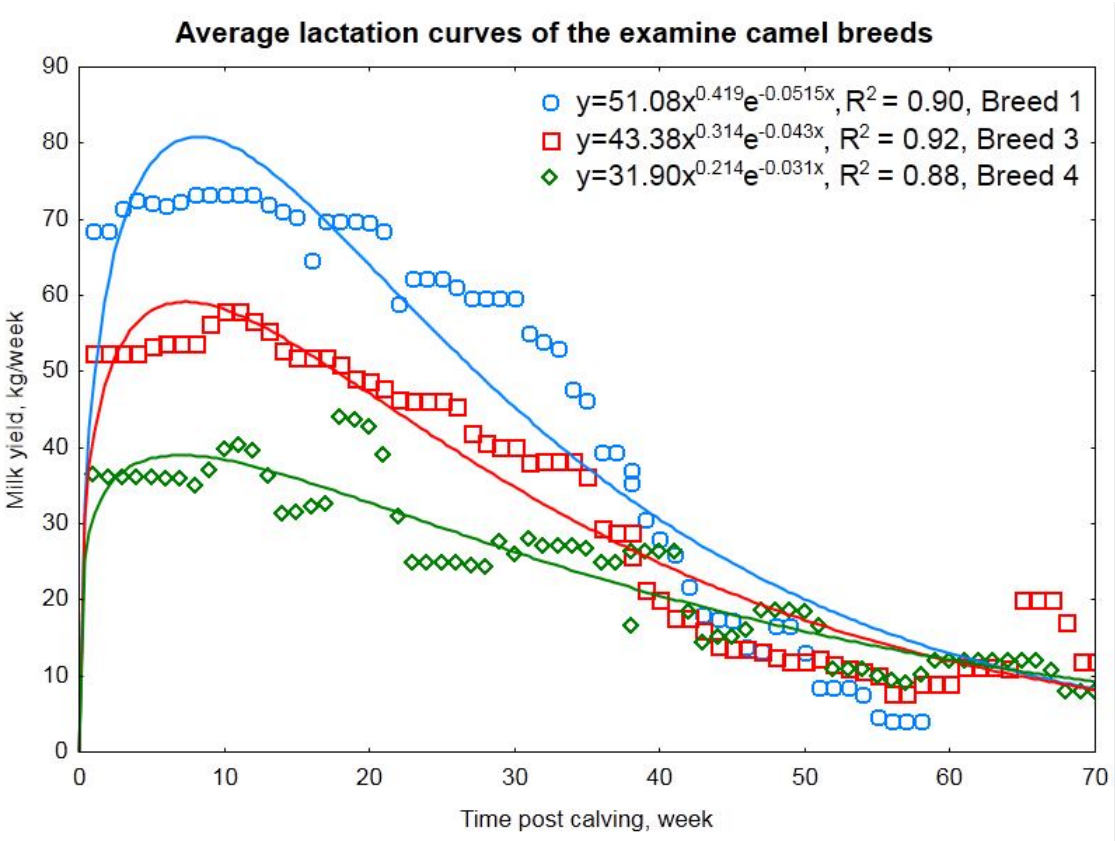

Figure 10: The average lactation curve of Bushari, Arabi and Anafi breeds

Breed 1= Bushari.

Breed 2= Arabi.

Breed 3= Anafi.

4.3: Milk composition:

4.3.1:Descriptive statistics of Milk composition and energy value:

Table (19) represens the means and standard error of the milk composition whichincluded the moisture, total solids, fat, lactose, Ca, Mg, Na, K, P and milk energy value.

Table 19: Descriptive statistics of Milk composition and energy value of camel milk.

Milk composition	**Mean (±SE)**
Moisture, %	89± 0.27
Total solids, %	11± 0.27
Ash, %	0.9± 0.02
Crud Protein (CP) , %	2.5± 0.08
FAT, %	3± 0.20
Lactose, %	4.7± 0.10
Calsium (Ca)	0.5± 0.08
Mgnesium (Mg)	0.13± 0.03
Sodium (Na)	0.20± 0.20
Potassium (K)	0.34± 0.04
Phosphorus (P)	0.27± 0.02
Milk energy value, MJ/kg of milk	2.52± 0.09

4.3.2:Milk composition and energy value of the studied Bushari, Arabi and Anafi breeds:

As is shown in Table (20) the Bushari, Arabi and Anafi she camels did not differ significantly in moisture, total solids, ash, lactose, Ca, Mg, Na, K and energy value. Bushari breed was significantly higher in crude protein and phosphorus than Arabi and Anafi breed, while Arabi breed was significantly lower in fat than Bushari and Anafi breed.

Table 20: Milk composition and energy value of the studied Bushari, Arabi and Anafi breeds.

Breeds	**Bushari**	**Arabi**	**Anafi**	**SE**	**p**	
Number of observations	6	6	5			
Moisture	88.45	89.76	88.88	0.424	0.108	NS
Total solids	11.55	10.22	11.12	0.420	0.097	NS
Ash	0.91	0.90	0.88	0.040	0.861	NS
Crud Protein (CP)	2.73^{a}	2.32^{b}	2.29^{b}	0.118	0.033	S*
FAT	3.15^{ab}	2.37^{b}	3.60^{a}	0.305	0.041	S*
lactose	4.89	4.74	4.39	0.149	0.096	NS
Calsium (Ca)	0.59	0.36	0.38	0.161	0.525	NS
Mgnesium (Mg)	0.18	0.09	0.09	0.055	0.444	NS
Sodium (Na)	0.27	0.17	0.17	0.032	0.080	NS
Potassium (K)	0.47	0.29	0.24	0.068	0.064	NS
Phosphorus (P)	0.36^{a}	0.23^{b}	0.20^{b}	0.037	0.024	S*
Energy value	2.68	2.26	2.66	0.148	0.110	NS

4.4: Matrix of coefficients of correlations of lactation performance traits and lactation curve components:

The matrix of correlation coefficients of the milk production performance and lactation curve parameters (Table 21) indicated that total milk yield correlated positively with all lactation curve component but correlated negatively with constant c and total body changes.

Table (21): Matrix of coefficients of correlations of lactation performance traits and lactation curve components of Bushari,Arabi and Anafi.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	total yield	1.00														
2	Lactation	0.20	1.00													
3	observed peak	0.84	-0.27	1.00												
4	persistency of	0.20	-0.90	0.58	1.00											
5	a	0.35	-0.45	0.68	0.61	1.00										
6	b	0.15	0.11	-0.03	-0.16	-0.71	1.00									
7	c	-0.13	0.33	-0.38	-0.52	-0.81	0.83	1.00								
8	week of peak	0.36	0.00	0.25	0.11	-0.47	0.86	0.46	1.00							
9	peak yield	0.86	-0.25	0.99	0.56	0.67	-0.03	-0.34	0.22	1.00						
10	persistency of	0.39	-0.23	0.39	0.38	-0.25	0.74	0.23	0.95	0.35	1.00					
11	0ffspring	0.41	-0.06	0.47	0.20	0.25	-0.01	-0.14	0.05	0.47	0.15	1.00				
12	offspring wt%	0.12	-0.21	0.18	0.24	0.12	-0.03	-0.05	-0.09	0.21	0.03	0.84	1.00			
13	calving wt	0.42	0.25	0.43	-0.07	0.20	-0.02	-0.21	0.20	0.37	0.19	0.31	-	1.00		
14	lactation end	0.22	0.20	0.21	-0.09	0.22	-0.23	-0.26	-0.12	0.19	-	0.07	-	0.81	1.00	
15	total body	-0.27	-0.04	-0.31	-0.03	0.05	-0.36	-0.12	-0.50	-0.25	-	-0.35	-	-0.18	0.44	1.00

4.5: Matrix of coefficients of correlations of lactation curve performance and milk composition traits ofBushari,Arabi and Anafi :

The matrix of correlation coefficients of the lactation performance and milk composition traits (Table 22) indicated that the total milk yield correlated positively with all milk composition components but correlated negatively with moisture, lactose and total body changes, while the lactation period correlated negatively with all the milk composition traits.

Table (22): Matrix of coefficients of correlations of lactation performance and milk composition traits of Bushari, Arabi and Anafi breeds.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	total yield	1.00															
2	Lactation period	0.20	1.00														
3	observed peak yield	0.84	-0.27	1.00													
4	total body change	-0.27	-0.04	-0.31	1.00												
5	Moisture	-0.18	0.65	-0.36	0.05	1.00											
6	TS	0.18	-0.64	0.37	-0.03	-1.00	1.00										
7	Ash	0.04	0.00	-0.09	0.63	-0.16	0.17	1.00									
8	CP	0.08	-0.85	0.54	0.07	-0.67	0.67	0.00	1.00								
9	FAT	0.15	-0.72	0.51	-0.20	-0.72	0.71	-0.08	0.78	1.00							
10	lactose	-0.14	-0.36	-0.22	0.44	-0.46	0.46	0.62	0.16	0.10	1.00						
11	Ca	0.18	-0.68	0.63	-0.33	-0.45	0.45	-0.36	0.74	0.63	-0.30	1.00					
12	MG	0.04	-0.67	0.55	-0.21	-0.34	0.35	-0.29	0.75	0.57	-0.32	0.96	1.00				
13	Na	0.18	-0.69	0.63	-0.21	-0.52	0.52	-0.29	0.89	0.83	-0.21	0.77	0.76	1.00			
14	K	0.14	-0.75	0.59	-0.02	-0.52	0.52	-0.01	0.94	0.82	-0.03	0.75	0.78	0.91	1.00		
15	P	0.35	-0.77	0.75	-0.29	-0.64	0.64	-0.25	0.86	0.81	0.01	0.84	0.78	0.86	0.82	1.00	
16	energy value	0.09	-0.83	0.44	-0.01	-0.81	0.81	0.11	0.85	0.94	0.39	0.54	0.49	0.76	0.81	0.79	1.00

Chapter Five
Discussion

Chapter five

5. Discussion

The survey showed that 81.8% of camel farms were located in Khartoum North and only 18.2% located in Omdurman. The majority of the camel owners were from western and eastern Sudan and to the nature of the area. 54.5% of farms had milk production as the only purpose of investment. This in line with Fay (2013) who mentioned that the camel farming systems move from extensive form to semi intensive or even intensive system in Suadi Arabia to meet the requires for milk production.

Out of eleven farms the herding types of camel only and camel with cattle were both 36.4%, this could be due to the preference of people to milk consumption from the two species, while herding camel and others represented (27.2%). This is in line with Simenew *et al.*(2013) who studied Somali pastoralists and it was indicated that keeping different livestock species by pastoralists is beneficial to sustain the pastoral livelihood during the worsening impacts of drought .

All owners in this study were above 40 years old this result agrees with the findings of Darosa and Agab (2005), and this may be due to the appearance of new and easy money-earning activities as well as the lack of some essential services needed by the young herders, such as education and health services, these discouraged the young camel herders to practice this profession.

36.3% of herd owners were non-educated; this result is lower than the findings of Abdalatif *et al.* (2011) who mentioned that illiteracy among the herd owners and their families reached as high as (69.78 %). This may indicate to the need for appropriate systems of education to suit the camel herders in order to improve their standard of living. The study found that owners with university and post graduate

level as (27.3%) for each. Professional owner represented the majority of owner relationship with camels at (63.6%).

The study showed that all herd men were employed by the owners with money payment as herd men and milkers. The herd men farm ranged from 1 to 5 as a high frequency (91%) while more than 5 herd men represented (9%). According tothe herd size and farm requirements. The present result agrees with Fekadu *et al.* (2013) who mentioned that hired labourers were the majority in camel herding of Somali pastoral areas. (54.5%) were educated at six farms this shows their awareness for education in order to develop and improve their standard of living followed by (45.5%) of herd men at five farms were illiterate because they did not find the chance to acquire education.

The systems of camel husbandry in this study were found to be intensive and semi-intensive systems which are line with Faye (2013) mentioned the camel farming systems move from extensive form to semi- intensive or even intensive system in Suadi Arabia, Ishaq *et al*. (2011) studied the production system in (in four regions of camels rearing in western, central and eastern Sudan) and found the majority of camel owners adopted a sedentary management system, followed by those owners adopted a nomadic system, while lowest of them adopted a transhumant system. In eastern Sudan Darosa and Agab (2005) recorded a percentage of (22%) of camel herders as transhumant nomads in contrast to (40.7%) as sedentary camel herders. Faye (2013) mentioned that the current changes in camel farming system based on intensification of the management.

In this study camels were found to belong to two main types, pack camels and riding camels, this agrees with El-Fadil (1986) and Darosa and Agab (2005)

who mentioned the presence of the heavy, slow baggage *Arabi* type and the light fast riding or racing type.

Seven camel breed eco-types were kept in Khartoum State, these are: (Arabi Bushari , Rashaidi,Anafi, Kabashi, Kinaniand Shukri). This is comparable to Darosa and Agab (2005) who reported eco-types in Butana as *Arabi* a, *Rashidi* ,*Diaili* ,*Annafi* and *Bishari*. The names of these subtypes are exclusively indicatives of the tribes owning these camel subtypes.

During this study Arabi breed and Rashaidi were found to be classified as heavy camels, this is in line with Elfadi (1986), Babiker (2000) and Darosa Agab (2005), While Anafi and Bushari were classified as riding camels, this agrees with Wardeh (2004), and Darosa and Agab(2005).

Faye (2008) and Simpickin(1994) mentioned that there are no well described genetically characterized breed in dromedaries, although there are considerable phenotypic variation among different types, in this study it was found that there are combinations of different types of camel in one farm for the main purpose of high milk production.

The present results revealed that herd size ranged from 12 up to 216 camel with mean (44), this is lower than the results of Ishaq and Ahmed (2011) who stated the average camel herd size as 75.3 heads while Falah(2004) stated the average herd size depends on method of management and aim of raising camels.

In this study the most frequent herd size was (11-20) (36.4%), similar result (10-20) camels in Algeria were reported by Falah (2004), followed by (31- 40) heads at (27.2 %) and this was considered as small herds, this is similar to Falah (2004) who mentioned that the camel herd is classified into small herds when the number of camel is less than 50. (9.1%) for both (51-60) and (more than 100herds) is

always nearly similar to herd size from (80 camels) in India and (192 heads) in the Eastern States of the Sudan (Sakr and Majid ,1998), but the pure result is far less than the average herd size owned by one family (380 camels) in Saudi Arabia and 310 camels. This generally depends on method of management, aims of raising camels.

All surveyed farms supplemented their camels with concentrates. About (73%) of the farms used green fodder like Abu70 and berseem while the rest fed their animals on pastures + concentrates or fed concentrates only, this result agrees with Falah (2004) who mentioned that camels can be fed concentrates and pasture crops , Faye (2013) reported that in intensive camel production , the technical model adopted by the farmer for the feeding system is mainly based in irrigated alfalfa plus concentrates like Barely and or wheat bran. on the other hand the camel usually consumes (25-40 kg) of good fodder per day with additional grain supplement for heavy working animals (Falah ,2004).

In the present study fresh water was available at all time in comparable to Nomads however Falah (2004) reported that they lived at a distance of not more than two-day walk from water sources. Interviewed camel herders reported that camels were watered at intervals of 5-7 days in the hot season, while in winter ranged from 10-14 days.

Camel consumes about 60-80 liters of water a day which means that one camel needs about 60 ml/ Kg body weight per day. This depends upon the outside temperature, the type of food and the season of the year (Falah, 2004). In this study National water net was the most frequent water sources (54.5%) followed by wells (36.4%) and canal (9.1%), this is in line with Coppock *et al.* (1988) and Falah (2004).

The average tolerance for salt in drinking water is no more than (1%) for cattle, (1.3-1.5%) for sheep and (5%) for camels (King, 1983). In the present study (54.5%) of farms did not add additives to the water and (36.4%) added bicarbonates and common salt, this is in line with Williamson and Payne (1978) who mentioned that salt is provided in salt pans or by salting the drinking wells or even feeding salt earth.

In the present study 100% of milking let down stimulation was done with the presences of the offspring and each she-camel was milked by one milker ,once she became 7-8 month pregnant, she kicked her calf when it tried to suck milk and also refused to be milked, this result agrees with Falah (2004). Milking all the udder represented (45.5%), this result agrees with Abdul Rziq *et al*. (2011) in Pakestan where Baluchistani camel were milked completely for all quarters, milking half of the udder was found at (36.3%) while (9.1%) was for the three quarters of the udder, this agrees with William and Payne (1978) all that depending on the strength of the calf and the milking ability of the dam. Concerning the milking frequency, high frequency was (81.8%) for she camels milked twice this agrees with Ramet (1987) and Ramet (1994a) ,(9.1%) were milked for three times, similar result of Kenya camels where Spencer (1973) reported that the Rendille tribe herders milk their camels three times in 24 hours. Four times were found at (9.1%) which agrees with Haratly (1980) stated that generally camels are milked 2 to 4 times a day, the present results were less than that of Falah (2004) who mentioned that Affair tribes in Ethiopia sometimes milk their camels six times a day and at other times they may leave them the whole day without milking. Frequencies of milking lactating camels depend on the customs. Al-Saiady *et al*.(2012) approved that increasing milking frequency to more than twice daily increases milk yield (i.e., 3 times daily, 5 to 10%; 4 times daily, 30%) .

The study revealed high frequency for lactation period was12 months at (54.5%) this is near to Simenew *et al.* (2013) was reported in Somalia camel the mean lactation length was (11.51±1.91) months. The present result is more than that reported Abdelgadir*et al.* (2013) (11 months) while Lactations vary between 12 and 18 month was reported by (Sallam*et al.*, 2015). The length of the lactation period was due to the herd owner management.

Rendille pastoralists of Kenya belived that one good milking camel can replace four to five cows (Schwatz and Schwartz ,1985).From this study findings the high frequency average daily milk yield/she-camel was recorded (4 kg/day) at (54.5%) this result agrees with Chimsa*et al.* (2010)) in eastern Ethiopia and with Darosa and Agab (2005) who stated that the average daily milk yield of five lactating camels in the open grazing system in Butana throughout one year was found to be (4.24kg/day), while Sallam *et al.* (2015) indicated that the averages daily milk yield for semi-intensive camels (8.24 ± 1.72 lit/day). The present result also showed that the production of milk as (2 kg / day) at (27.5%) and (5 kg/day) at (9.1%), this is nearly similar to Chimsa (2014) who reported the daily milk yield of Pakistani camel in the range from (4 to7 liter/day) , while Sallam *et al.* (2015) indicated that the averages daily milk yield for semi-intensive camels 8.24 ± 1.72 lit/day also Abdelgadir *et al.* (2013) mentioned daily milk yield of camel in Syria (7.3 to 12.2) litres all above results were lower than Al-Saiady *et al.*(2012) reported that daily milk yield from she camel vary from (15 to 40 kg/day) and Simenew *et al.* (2013) who reported the daily milk yield of Somali camels ranged from (1-20) litres per day, may be due to camel breeds and management. On the other hand the average daily total milk yield/farm for 5 farms was above (80 kg) at (45.4%) followed by 3 farms their average daily total milk yield/farm ranged (20-40 kg) at (27.3%).Bakheit *et al.* (2008) reported that the farming management has

a high impact on the expected productivity. While Rania (2012) mentioned factors that affect camel milk production included: camel breed, nutritional factors and stage of lactation and milking practices such as: calf suckling, milking frequencies, milking performance method and drinking water ability,Age, parityand season.

Most of the camel milk is drunk fresh, slightly sour, strongly soured or drunk sweetened with sugar .This study found that camel milk had been processed to Gariss at (63.6%) , this result is in line with Dirar (1993) who defiended Gariss" is a special kind of fermented camel milk prepared solely under more or less continues shaking. The product is prepared and consumed by camel herders commonly in eastern Sudan Elagab and Elfaki (2000), also they indicated that in Kassala and Tambol the products is called "roub". This study found Gariss was preferable due to the taste and it is medical properties, this result agrees with the findings of Rania (2012). In the present study (27.3%) of camel milk was used of non-processed in believe that un processed, camel milk has medicinal properties which would otherwise be lost through heating. During this study it was found only one farm used to heat then pack the camel milk.

One farm (9.1%) processed ice cream from camel milk this is in line with Rania (2012) who reported that camel milk ice cream had been launched first in the United Arab Emirates (UAE) at Al-Ain. The product was healthy and could be an alternative to other ice cream products. Camel milk ice cream was found to contain only (2.5%) fat, compared to that between (6 to 9 %) for standard ice cream and added to that Camel ice cream is safe for consumers with lactose intolerance and contains 3 times more vitamin C than cow's milk ice cream (Pathak and Bhagat, 2010). Prajapapati *et al* (2012) mentioned that ice cream and frozen desserts were successfully produced from camel milk.

The aim of any investor is to achieve high revenue. In this study the total revenue form milk marketing ranged from 0.972 up to 30.912 thousand Sudanese Pound depending on the numbers of lactating she-camels, lactation length and the price of Kg of camel milk. The study found 6 farms out of 9 were selling the camel milk in the farm gate followed by (27.3%) of farms were selling this milk in the farm and marketing centers this result is in line with Issack *et al.* (2013). 6.8 Sudanese pound was the milk price for kg of camel milk in 5 farms (equivalent to US$1.1) this result was higher than Issack *et al.* (2013) who mentioned the price of fresh milk sold in Nairobi urban markets (equivalent to US$0.4) but lower than the price of processed milk (equivalent to US$3.5).

In this study most of the farms there was lack of understanding of the principles of clean milk production, this is in line with Issack *et al.* (2013) while CARE Kenya(2009)solved this problem by training camel milk marketing groups in Garissa to produce a high volumes of good quality milk

The present study estimated the average milk yield for the study breeds Arabi(plate 8), Anafi(plate 9) and Bushari(plate 10) was (1932±360Kg) while the world level milk production for camel is 2500 kg/year on average in 2008 Al-Saiady *et al.* (2012) , this result was near to Darosa and Agab (2005) reported the average total milk yield in Butana in the sedentary system per lactation as 2925 kg ,in the open grazing system and average total milk yield of these camels per lactation was found to be 1654.4 kg . The overall mean of total milk yield is comparable to that mean reported by Abdelgadir*et al*. (2013) for multi breed dairy camel herd in the Sudan; they reported 1970 ± 790 kg. Higher value (2300 kg/season) was reported by Ismail and Al-Mutairi (1990). Comparable yield for longer lactation period was reported in Ethiopia by Belay and Getahun (2002) noted that the lactation milk yield per dam in the Jijiga Site was 2000 kg with an average lactation length of 15 month. The present lactation period is comparable to 12.5 months that reported by Musaad *et al*. (2013) and to the range (12.0 – 16.8 months) reported by Gebrehiwet (1998) in Eritrea. In the present study the weekly peak yield is comparable to 50.7 kg milk /week but persistency index was lower than 94.7% those reported by Musaad *et al*. (2013). The Bushari she- camels had the highest weekly peak yield and persistency index. However, Anafi she- camels were those milked their back and lost weight during lactation.

The Bushari, Arabi and Anafi she camels did not differ in all of the lactation curve components. The average lactation curve of the present she-camels started at an initial weekly yield scale of 45.4 ± 20.76 kg/week and increased at a rate of 0.304 ± 0.238 kg/week to reach a peak yield of 63.5 ± 24.25 kg/week after 7.6 ± 2.92 weeks post calving. This peak persisted for 4.6 ± 1.17 weeks before decreasing at a rate of 0.038 ± 0.020 kg/week to the end of lactation period. However the Anafi she-camel had the lowest rate of decrease from the peak yield (0.021kg/week) than

the Bushari and Arabi groups (0.037 and 0.052 kg/week, respectively) those were similar, indicating the flatter lactation curve of Anafi she-camels (Tekerli *et al*., 2000).

The similarity of the three she- camels groups in the average estimated calving body weight indicated that it was not due to source of variation in the lactation performance. The birth calf weight percentage of dam's calving weight was similar for the three groups and it was comparable to 8.3% that stated by AFRC (1993) as the maximum gestation output in term of kg offspring born/ kg calving dam. This

Indicated that the management and feeding level is sufficient to allow the she-camels to produce their maximum. Also there were no differences between the

three she- camels groups in the total milk yield, lactation period and she-camel weight at end of lactation.

The study estimated the average calf weight (35.2$\pm$ 2.42) kg this result was in line with Musaad *et al*. (2013) at (36)kg but lower than Ihuthia*et al*. (2010)who reported (44.9 ± 0.26) kg for camel calves

The matrix of correlation coefficients of the milk production performance and lactation curve parameters indicated that total milk yield correlated positively with all lactation curve component but correlated negatively with constant c and total body changes. This result disgreed with Abdelgadir*et al.* (2013) who reported the correlation between milk production and milk components was significantly negative in addition to that there was no relationship observed between dam weight and milk production this may be due to the breed.

The matrix of correlation coefficients of the lactation performance and milk composition traits showed that the total milk yield correlated positively with all

milk composition components but correlated negatively with moisture, lactose and total body changes, while the lactation period correlated negatively with all the milk composition traits. While Abdul *Raziq et al.* (2011) mentioned that there was a negative correlation between the fat content in camel milk and the milk yield this may be due to the breed.

Several factors affect milk composition, including the genetic factors, Physiological factors and age (Falah ,1997) and the stage of lactation (Rania ,2012) type and standard of pasture (Gera*et al*.,2007), feeding conditions and water availability (Mohammed and Hijrot ,1993).

The milk composition of the studied Bushari, Arabi and Anafi she-camels showed that there was no significant differences ($p>0.05$) between the three she camels in in moisture, total solids, ash, lactose, Ca, Mg, Na, K and energy value.

In the present study the mean for total moisturewas (89$\pm$ 0.27%), this is in line with Rania (2012) who reported that the water content of Suadi Arabian camel milk was(88.4%) and Falah (2004) who mentioned that when water is freely accessible, the water content of the milk was 86%. But when water was restricted the water content of milk rose to (91%).

In this study the mean for total ash was (0.9$\pm$ 0.02%) which is higher than Musaad *et al.* (2013) (0.74 to 0.82 %) and Falah (2004) (0.6 to 0.8%). The mean for Ca was (0.5$\pm$ 0.08%), Mg (0.13$\pm$ 0.03%), Na (0.20$\pm$ 0.20%) and K (0.34$\pm$ 0.04%) comparable with the findings of Gera *etal*. (2007) who reported that calciumwas (110$\pm$38.47 mg/dl) while Konuspayeva *et al.* (2009)*found* calcium varied between (1.00 and 1.40 g/l) , magnesium (8.4$\pm$0.29 mg/dl), sodium (24.60$\pm$1.17mEq/L) and potassium (28.52$\pm$2.28 mEq/L). Bushari breed is significantly higher in phosphorus (0.27$\pm$ 0.02%) than Arabi and Anafi breed, this may be due to breed

diffrences, the result was lower than Konuspayeva *et al.*(2009) who mentioned that phosphorus between (0.75 and 1.10 g/l), the present result agree with Qureshi (1986) who mentioned that phosphorus content of camel milk is higher than that of cows, buffalo, sheep and goats, It is therefore evident that camel milk in many aspects is superior to the milk of other domestic animals. Gera *et al*. (2007) found that phosphorus was (80.3±0.46 mg/dl).

Ahmed (1988) mentioned that levels of sodium, potassium, zinc, iron, copper and manganese were higher in camel milk than those of cattle milk. Moreover all major minerals were higher in mature she camel milk than in humans which tempted some people to recommend it as a good nutritional source of these minerals (Gorban and Izzeldin ,1997).

The presnt study revealed the mean for total lactose was (4.7± 0.1%), this is in line with Konuspayeva *et al.* (2009) they reported (4.46± 1.03%), while Omer (1996) compared lactose concentration of camel milk in some countries and found that it was (4.4 %) in Saudi Arabia, (3.2) % in India and (3.5%) in Pakistan.

Yagil and Etzion (1980) Wilson (1984) Elamin (1992) and Falah (2004) reported lactose level of (2.4 – 5.3 %), (4.8-5.8%) and (2.52%) respectively , Musaad *et al.* (2013)found arange of 4.02 to 4.41 for lactose.

The mean for total crude protein in this study was (2.5± 0.08%) near to Knoess (1977), Sawaya *et al.* (1984), Elamin and Wilex (1992) and Farah (1993) but lower than Dirar (1993) (3.3 – 4.7%) and Musaad *et al.* (2013) at (2.91 - 3.22). the study found that Bushari breed is significantly higher than Arabi and Anafi in crude protein (2.73%) may be due to breed.

The mean for total fat in this study was (3± 0.2%). This is with the range reported by Konuspayeva *et al.* (2009) *at* (3.82± 1.08%), Musaad *et al.* (2013) at (2.00 to

2.98 %), (2.9- 5.4%) Falah (2004) and (1.9 -5.6%) Bayoumi (1990) and Elamin (1992) but thepresented result is lower than (4.6 %) reported by Mohamed (1990) while Qureshi (1986) found that the fat content is equal to cow milk. This study showed that Arabi breed is significantly lower in fat (2.37%) than Bushari and Anafi breed.

Chapter Six

Conclusions

&

Recommendations

5-2 Conclusions

- The survey showed that 81.8% of intensive camel farmswere located in Khartoum North and only 18.2% located in Omdurman.
- All owners in this study were above 40 years old, 36.3% of them were non-educated.
- Seven camel breed eco-types were kept in Khartoum State, these are: (ArabiBushari , Rashaidi,Anafi, Kabashi, Kinaniand Shukri).
- That herd size ranged from 12 up to 216 camels and the most frequent herd size was (11-20) heads.
- Most of the questioneered rank investment in milk as priority followed by milk and meat production.
- All milking let down stimulation was done with the presence of the offspring and each she-camel was milked by one milker.
- The average daily milk yield/ she camel was found to be 4 kg/day. On the other hand the average daily total milk yield/ farm ranged 20-40 kg/day. The average milk yield for Arabi, Anafi and Bushari breeds was 1932$\pm$ 360 Kg.
- The estimated average calf weight was (35.2$\pm$ 2.42) kg.
- The Bushari, Arabi and Anafi she camels did not differ significantly in all of the parameters of the yield at the beginning of lactation (constant a).
- Bushari breed was significantly higher in crude protein and phosphorus than Arabi and Anafi breed, while Arabi breed was significantly lower in fat than Bushari and Anafi breed.
- The total milk yield correlated positively with all lactation curve component but correlated negatively with constant c and total body changes.

- The total milk yield correlated positively with all milk composition components but correlated negatively with moisture, lactose and total body changes, while the lactation period correlated negatively with all the milk composition traits.
- Gariss was preferred due to the taste and medicinal curing of camel milk.
- The total revenue in the present study ranged from 0.972 up to 30.912 thousand SudanesePound. 6.8 Sudanese Pound was the milk price for kg of milk in most farms.
- In most farms there was lack of understanding safety, hygiene and principles of clean milk production.

٥.٣ Recommendations

- Records for every camel farms are recommended.
- Establishment of machine milking and processing to develop biologically, environmentally and financially sustainable, intensive camel milk production system.
- Reproduction techniques such as artificial insemination and embryo transfer should be promoted.
- Milking of she-camel without the presence of the calf should be adopted.
- Training camel milk marketing groups to market high quality milk.
- More research with large size of she-camels and more camel types.
- Incorporating camel milk management, production and processing in the Animal Production curricula of Sudan University of Science and Technology and other universities and educational institutes.

REFERENCES

References

Abdalatif Y. M., Eisa M. O., Mustafa A. B. and Salih A. M. (2011).Constraints of camel pastoralists in Gedarif state, Eastern Sudan. Research Openionsin Animal& Veterinary Sciences,ISSN 2221-1896.

Abdelgadir M. Musaad, Bernard Faye and Sallal E. Al-Mutairi.(2013). Seasonal and physiological variation of gross composition of camel milk in Saudi Arabia.***J. Food Agric***. 2013. 25 (8): 618-624 doi: 10.9755/ejfa.v25i8.16095.

Abdelgadir, W. S; T. K. Ahmed and H. A. Dirar. (1998). The traditional fermented milk product of the Sudan. Inter. *J. of Food Microbiology* vol. (44) page (1-13).

Abdul Raziq, Kerstin de Verdier, Muhammad Younas, Sarzamin Khan, Arshad Iqbal and Muhammad Sajjad Khan.(2011). Milk composition in the Kohi camel of mountainous Balochistan, Pakistan.*Journal of Camelid Science* 4 - 49–62.

Abeiderrahman, N. (1997). Camel milk and modern industry.*J.of Camel Practice and Research*. Vol 4, No 2, pp 223-228.

Abu Sin, M. F. (1990). Literature survey.Base line informatin and profile of centeral. UNDP, Area Development Programmed

Abu-Lehia,I.H. (**1994)**. Recombined camels milk powder. Workshope and camel milk, 24-26 October,1994. Nouakchott, Muritania.

Acand,P.B.E. (1932). Notes on the camel in eastern Sudan. Sudan Notes Rec. 15(1): pp. 119-149.

AFRC.(1993). Energy and Protein Requirements of Ruminants. CABI Publishing, Wallingford.

Agab, H. (1993). Epidemology of Camel Diseases in Eastern Sudan with Emphasis on Brucellosis.M.V.Sc.applied research and development network/CARDN/ACSAD/ Camel/p30/ 1-27.

Aggarwalda, A.C and R.M.Sharma.(1961). A laboratory manual of milk inspection.Asia Publishing House.

Agrawel, R. P., R. Beniwal., S. Sharma., D. K. Kochor, F. C. Tuteja and M. S. Sahani.(2005). Effect of raw camel milk in type (1) diabetic patients JCPR (1).

Ahmed, A.A.; Y.L Awad and F.Fahmy.(1977). Studies on some minor constituents of camel milk. Vet. Med.1, 25: 51 - 56.

Ahmed, M.M. (1988).The analysis and quality of camels milk, Higher Digree, Thesis, University of Reading, UK.

Al-Saiady, M. Y., Mogawer, H. H., Faye, B., Al-Mutairi, S. E., Bengoumi, M., Musaad, A. and Gar-Elnaby, A. (2012). Some factors affecting dairy she-camel performance. *J. Food Agric*. 2012. 24 (1): 85-91.

Amasaib, E. O., Mohamed, H. E., Ishag, I.A., El Zubeir, I. E. M. (2013). The status of camel milk production in Sudan.Proceeding of Conference of Sustainability of Camel Population and Production (CSCPP).Alhufof, KSA.

AOAC.(1990). Official Methods of Analysis, 15^{thed}., Association of Official Analytical Chemists, Washington D.C., USA.

Aujla,K.M; A.W.Jasara and M.Munir.(1998). The socio-economic profile of camel herders in South-western Mountainous Areas of Pakistan.Proceeding of the Third Annual Meeting for Animal Production under Arid condition, Vol.2:154-174.

Babiker, S.A. (2000). Principle of Animal Production.Curriculum Administration, Ministry of Education. Khartoum, Sudan.

Bahargava, K.K., Sharma, V.D. and Singh, M.(1965). A study of birth weight and body measurement of camels (Camelus dromedarius). Ind. *J, Vet. Sci. and Anim. Husb*. 35(1): pp 358-362.

Bakheit, S.A, Abu-Nikheila A. M, Kijora C. and Faye B. (2008). The impact of farming system on Sudanese Camel milk production', Proceedings of WBC/ICAR .2008, Satellite meeting on camelid reproduction', Budapest (Hungary), 12-13 July 2008, P. Nagy and G. Huscenicza (Eds), pp 88-90.

Bayoumi, S. (1990).Studies on composition and rennet coagulation of camel milk.Milchwirtschaft, 42: 3 8.

Belay, K., T .Getahun. (2002). Production and Utilization of Camel Milk in Eastern Ethiopia. The case of Jijgan and Shinnili Zones (A survey), *J. Folia Veterinaria* 46, 2:75.

Benkerroum.N., M. Mekkaoui; N. Bennani and K. Hidane.(2004). Antimicrobial activity of camel milk against pathogenic strains of Escherichia Coli and Listeria monocytogenes. Inter. *J. of Diary Technology* V (57) page 39.

Bullet, R.W. (1975).The camel and the wheel, Harvard, University Press, Cambridge.

Burgemeister, R. (1975). Elevage de chameaux en Afrique du Nord.Eschborn, GTZ (gesellschaft fur Tachnische Zusammenarbiet), 86 pp.

Burntse, A. (2002).Camel milk products.Proceedings of the 8th Kenya camel forum.PP.52-53.

Camel Milk Hygiene and Business Skills Training_CARE Kenya. (2009). A Report on Camel Milk Marketing Clusters in Garissa Commissioned by CARE Kenya under Enhanced Livelihoods in the Mandera Triangle (ELMT) Project Report compiled by SITE.Garissa, Kenya.

Chimsa, M. B., Mummed, Y. Y., Kurtu, M Y , Leta, M U. (2010). Milk productivity of Camel and growth of calves (Camelusdromedarius) in eastern Ethiopia.

Clarence, E.H; W.B Comb and H.Macy.(1982). Milk and milk products, University of Minnesota.Fourth edition.

Cole, D.P. (1975). Nomads of the nomads: The Al Murrah Bedouin of the Empty Quarter. Chicago, Aldine Publishing Co.179 pp.

Coppock, D.L., Ellis, J.E. and Swift, D.M. (1988). Seasonal patterns of activity, travel and water intake for livestock South Turkana, Kenya. J. Arid Enviroments. 14: 319-331.

Cossins, N.J .(1971). Pastoralism under pressure: A study of the Somali clans in the Jijiga area of Ethiopia. Mimeo, Addis Ababa,LMB (Livestock and Meat Board), 101 pp.

Dahl, G. and Hjort, A. (1976). Having herds: Pastoral herd growth and household economy.University of Stockholm, Department of social Anthropology, 355pp.

Darosa, A. E. M. and Agab, H. (2005). Studies on some camel (*Camelus dromedarius*)production traits, health and constraints in Butana area, Sudan.

Dirar, H.A. (1993).Gariss Dairy Products In the indigenous femented foods of the Sudan and Nutrition. Astudy in African Food and Nutrition .First edition, University Press, Cambridge.

Dukwal, V., S. Modi and Singh, M. (2007).A comparative study of nutritional composition of camel and cow's milk.Camel conf-Book.International Camel Conference. Bikaner, India.

Elagab, M.A. and Elfaki, A.A (2000).The dairy Products and Globalization challenges- troubles and solutions.Seminar of Quality Control of food processing and future visions for third Millennium.Arab Organization for Agriculture Development Khartoum.

El-Agamy, E.I. (2006). Camel milk, Park, Haenlan, Editors , Hand book of milk of non-bovine mammals, Blackwell, USA (2006).

Elamin,F.M. and Wilex,C.J.(1992). Milk Composition of Majaheim camels *J. of Dairy Science* 75, 3155-5157.

El-Bashir.O.M. (1997).Physiological characters and Diseases of camel in the Sudan (in Arabic).Ms.c.thesis.University of Islamic Omdrman.

El-Fadil, S.A. (1986). Study on the mechanism of resistance to camel diseases. Dissertation submitted in partial fulfilment of the requirements for the degree of Doctor of Agricultural Science. GeorgeAugustuniversity,Gottingen.

El-Hofi.M. H and El-Tanboly., E. (2006).Application of Heat-Shock Treatment to overcome the problem of Yeast Contamination in Yoghurt Manufacture from the camel's milk. The International Scientific Conference of camels.Qaseem,Saudi Arabia.

Epstein, H. (1971). The origin of domestic animals of Africa.African Pub.Corp, New York.

F.F.S.R. (1976). The fertilizer and feeding stuffs regulation H.M.S.O., 49 High Holborn, London WCIV 6 HB.

Falah K. A. (2004). Camel Management and Diseases. 1st Eds. Al-Sharq Printing Press.

Falah.K.A. (1997).Camel Encyclopaaedia.Alfurgan printer and publishers, 1st.Ed.Pp110-121.(Arabic).

Farah, Z. and Fischer, A. (2004). Milk and meat from the camel: Handbook on productsand processing. 1st.Eds. ETH Eidegenossische Technische Hochscule Zuric, Swiss Federal Institute of Technology, Zurich.Ppp. 230.

Farah, Z., Younas, M. (2005). Camel dairy in Eastern Africa: present state and future perspectives . In Faye, B., Esenov, P.(eds.) Desrtification combat and food

safty. The added value of camel producers . (NATO Science Series), ISO Press, Amsterdam, Netherlands, pp 173-180.

Farah,Z .Rettenmair,R.and Atkins,D.(1992). Vitamin content of camel milk.Internat.*J.Vit.Nutr*.,62:30-32

Farah,Z.(1993). Composition and Characteristics of camel milk.*J. of Dairy Science* 60,603-626.

Faye, B. (2004). Dairy productivity potential of camels.Proc. of the 3^{4th}meeting FAO/ICAR (International Committee for Animal Recording). Session on camelids. 28 mai-3 juin 2004, Sousse (Tunisie), pp 93-105.

Faye, B. (2008). Dairy productivity potential of camels. In: Cardellion, R., Rosati, A., Mosconi, C. (eds) Current status of genetic resources, recording and production system in African, Asian and American Camelids. ICAR technical series No. 11., Proceeding of the ICAR/ FAOSeminar, Sousse, Tunisia, 30 May 2004, ICAR, Rome, Italy, pp.93-104.

Faye, B. (2009). 'L'élevage des grands camélidés : vers un changement de paradigme. Renc. Rech. Ruminants 16: 345-348.

Faye, B. (2013). Farming sustainability: The Challenges of the Camel Farming System In the XXIth Century. The International Conference of sustainability of Camel Population and Production. College of Agricultural and Food Sciences, King Faisal University, Saudi Arabia, 17 -20th February2013 .

Faye, B., Abdelhadi, O. M. A., Ahmed A. I. and Bakheit S. A.(2011.) Camel in Sudan: future prospects. *Livestock Research for Rural Development.Volume 23, Article #219.*Retrieved October 12, 2011.

Faye, B., Kanuspayeva, G. (2012). The Sustainability Challenge of the Dairy Sector.The growing importance of the non-cattle milk production worldwide.*Int. Dairy J.* 24: 50-56.

Field, C.R. (1979). Camel growth and milk production in Marsabit district, northern Kenya. In: Cocrrell,(EDS). The camelids an all-purpose animal.Processing of the Khartoum Workshop on Camels.December, 1979.Scandinavian Institute of African Studies, Uppsala, Sweden.Pp.209-230.

Field,C.R. (1979a). Ecology and management of camels, sheep and goats in northen Kenya.Mimeo, Nairobi, UNEP/MAB-IPAL (United Nation Environment Programme/Man and Biosphere-Integrated project in Arid lands), 18pp.

Gebrehiwet, T. (1998). The camel in Eritrea: an all-purpose animal. Animal resources Department, Ministry of Agriculture. Asmara, Eritrea.

Gera,S., Dabur, R. S., Virmani, M., sharma,A., Garg, S. L., and Jain, V. K. (2007). Studies in camel milk composition in migratory herds of camel in Haryana. Camel conf-Book.International Camel Conference. Bikaner, India.

Gorban, A.M. and Izzeldin, O.M. (1997).Mineral content of camel milk and colostrum.*J. of Dairy Research*, 64 (3): 471- 474.

Grounda, T. A. (1996). Economic importance of camel milk, Graduation report (in Arabic), school of veterinary medicine, Baath University, Arab Syrian Republic.

Hanson, A. (1950). The atomic absorption spectroscopy method for minerals.*J. of Sci. of Food and Agric*., 1: 172-174.

Haratly, B.J (1980). Camels in the horn of Africa.IFS Workshop in Camels. Khartoum, the Sudan.

Hassan, A.A, A.E Hagrass, K.A.Soyal, S.A.Elshabrawy, and Shabrawy, S.AE. (1987). Physiochemical properties of camel milk during lactation period in Egypt. Egyptian *J.of Food Science*, 15: 1-14.

Ibrahim,A.E.(1998) . Potential of milk production from Sudanese she-camels(Nagas). The Sudan *J,Vet.Res*., 15:57-59.

Ihuthia Peter Mungai, Wahome Raphael Githaiga, Wanyoike Margaret M. M. (2010). Correlation of actual live weight and estimates of live weights of Camel calves (Camelus dromedarius) in Samburu District of Northern Kenya. *Journal of Camelid Science* 3 (2010) 26-32.

Indra, R. and Erdenebaatar, B. (1994). Camel milk processing and its consumption pattern in Mongolia. In: Proc. Chameauxe, Dromedaries, Animauz Laitiers. Conf. Nouakchott, Mauritanie.

Ishag I. A., Eisa, M. O. and Ahmed M.-K. A. (2011). Characterization of production system of Sudanese camel breeds. Livestock Research for Rural Development 23 (3) 2011.

Ismail, M.D. and Al- Mutairi,S.E. (1990). Production parameters of Saudi camels under improved management system, Proc. Int. Conf. Camel Prod. Improv. , 10-13 Dec. Tobruk. l.ibya.

Issack Mohamed Noor, Abdi Yakub Guliye, Muhammad Tariq and Bockline Omedo Bebe. (2013). sessment of camel and camel milk marketing practices in an emerging peri-urban production system in Isiolo County, Kenya. Pastoralism: Research, Policy and Practice 2013, 3:28 doi:10.1186/2041-7136-3-28.

Izzaddin, O. H. (2002). Camel milk. *J. Science and Technology*, No. (68).

Johanson, I. and Rendel, J. (1968). Trans. Taylor, M. Genetics and animal breeding. Endinburgh, Oliver and Boud Ltd, 489 pp.

Joshi.R., Purchit,V., Purchit, S.K. and Arora,A. (2007). Feasibility of low pressure U treatment for maintenance of hygiene of raw dromedary milk. Camel conf-Book. International Camel Conference. Bikaner, India.

Karray, N. L.Danthine, S.Blecker, C.Attia, H.Karray, N. L.Danthine, S.Blecker, C.Attia, H. (2006). *International Journal of Food Sciences and Nutrition.Vol*. 57, No. 5/6, pp. 382-390)

Khanna,N.D.(1999). Sustainable camel production and improvement in rural sector for India dry land. Ex-Director. National Research Center of Camel, Bikaner (Rajasthan) India. ACSAD/CARADN/Camel/P 16/1997. Damascus. Pp22:44. Khartoum.

King, J.M. (1983). Livestock water needs in pastoral Africa in relation to climate and forage. ILCA Res. Rep. No.7. International Livestock Center for Africa: Addis Ababa.

Knoess, K .H. (1979). Milk production of the dromedary Camels. 1FS Symposium, Khartoum, Sudan, 201 - 214.

Knoess, K.H, Makhudum, A.J, Rafiq, M, Hafeez, M. (1986). Milk production potential of the dromedary, with special reference to the province of Punjab, Pakistan. World Animal Review 57, 11–21.

Knoess, K.H. (1977). The camel as a meat and milk animal .World Animal Review, N0.22:39-44.

Knoess, K.H. (1982). Utilization of camel milk therapeutic: milk production of the dromedary. *Pakistan vet.J.* 2(2):91-98.

Knoss, K.H. (1976). Assignment report on animal production in the middle Awash vally. Rome, FAO(Food and Agriculture Organization), 57pp.

Konuspayeva Gaukhar, Faye Bernard , Loiseau Gérard ,Narmuratova Meiramkul , Ivashchenko Anatoly , Meldebekova Aliya and Davletov Sydyk. (2009). Physiological change in camel milk composition (*Camelus dromedarius*) 1. Effect of lactation stage. Trop Anim Health Prod, 42:495–499DOI 10.1007/s11250-009-9449-x.

Leese, A.S. (1927). A treatise on the one humped camel in health and disease. Stamford(Lincs), Hayness and Son, 382 pp.

lsmail, M.D. and S.E. Al- Mutairi. (1990). Production parameters of Saudi camels under improved management system, Proc. Int. Conf. Camel Prod.Improv. , 10-13 Dec. Tobruk. l.ibya.

Mares, R.G (1954). Animal husbandry, Animal industry and Animal disease in the Somaliland Protectorate. Parts 1 and 2. Brit. Vet. 110(7): pp. 422-423, 470-481.

Mares,R.G. (1959). The African nomad: East Africa. In Introduction to animal husbandry in the tropics, eds Williamson, G and Payne, W.S.A. 2nd ed. London, Longman, pp 424-430.

MARF. (2010). Ministry ofAnimal Resource and Fisheries, Department of statistics, Annual reports.

Marshal, R.T. (1993). Standard methods for the examination of dairy product. American Public Health Association, Washington DC., USA.

Matharu, B.S. (1966). Animal management: Camel care. Offprint from India Farming, October 1966: pp. 19-22.

Mehta, S. C, B., Bhardwaj, S., Arora, Bhatnagar, A. and K. Pathak, M. L. (2007). Camel milk, a source of live hood and substance of camel. Camel conf-Book. International Camel Conference. Bikaner,India.

Ministry of Animal Resource., (2005). Department of Statistics and Information, Khartoum-Sudan.

Mishra, P,K. Mishra, K. and Nayak, J.B. (1978). Relation of mammary measurements with milk yield in dairy cows. *Indian J. Dairy sci*. 31(3):214-219.

Mohamed, M.A and A.Hjort. (1993). Camel (Camelus Dromedarius) milk Chemical composition and traditional preservation methods. The multi purpose camel ^Interdisciplinary studies on pastoral production in Somalia. 177-185; 28.

Mohamed, M.A. (1990). Camel milk: chemical composition, characterization of casein and preliminary trial of cheese-making properties. Swedish University of Agriculture Sciences, Uppsala, Sweden.

Nagy, P, J. Juhasz and O. Marko.(2007). Production of high quality (raw) camel milk, Determination of major control points in a large scale camel milking farm. Camel conf-Book. International Camel Conference. Bikaner, India.

Nagy, P. and Juhanz, J. (2013). Strategies to Increase the Quality and to Improve the Quality of Camel Milk Produced Under Intensive Management System. Conference of Sustainability of Camel Population and Production(CSCPP). Alhufof, KSA.

Omer, A. Sh. Abdelrahman. (1996). Studies in Mastitis in the camel. Ph. D. Thesis. Uppsala, Sweden.

Omer, R .H. (2001). Studies on camel milk deterioration trend. Ph.D.Thesis. University of Khartoum.

Pant, R. and Chandro,P. (1980). Composition of cow and camel milk 35:91-93.

Pathak, KML and Bhagat, C. (2010). New dimension for camel rearing . ICAR News. Vol. 17, Jan- Mar. 16-17p.

Payne, W. and Wilson, R. T. (1999). An Introduction to animal husbandary in the tropics. Back well Science, London.

Prajapati, J. P., Pinto. V. S., Wadhwani, K. N., Patel, A. B. (2012). Utilization of kachchi camel milk for manufacturing of medium fat ice cream. Proceedings of the 3rd Conference of the International Society of camelid Research and Development (29th Jan-1st Feb). Muscat, Sultanate Oman.

Qureshi, M.H. (1986). The camel. A paper presented at a seminar on the camel, Kuwait. 20–23 October. pp. 1–35. FAO, Rome.

Ramet, J.P. (1987). Roduction de formages a partir de lait de chamelle en Tunsie Mission Report. Rome, FAO.

Ramet, J.P. (1994a). Les aspects scientifiques et technologiques particuliers de la fabrication des fromages an lait de dromedaire comm.ColL Dromadaires et chameaux: animaux laitiers. Nouakchott, Momtania.

Rania, H. **Zayed. (2012)**. Production and consumption of camel milk in Khartoum State, Sudan. 1st ed .Lab Lambert,German.

Raziq A, Younas M. (2006). White camels of Baluchistan. Science International, 18, 51–52

Rollefson, IK.(2005). Camels on Rapid Decline in Asia. League for Pastoral Peoples. [cited 10 July 2007]. Available from URL: http://www.pastoralpeoples.org/docs/camels_decline_17jun05.pdf

Sabiel, A. F. B. (1999). Studies on milk production and composition of camel under nomadic system, Faculty of Animal Production, University of Khartoum.

Sakr, I. and A.M.Majid.(1998). The social Ecnomic of Camel Herders in Eastern Sudan. The camel Applied Research and development Network/CARDAC'ASCAD/Camel/p30/1-27.

Sallam A. Bakheit, Ali A. Hassabo, Adam I. Ahamed, Idriss A. Idriss and Khalid E. Sahel.(2015). Impact of Improving Management System on Sudanese Camel Milk Production. The Regional Conference of Camel Management and Production under Open range System (RCCMPR), Khartoum-Sudan, 2nd -4th March 2015 .

Sallam, A.S. (1999). Studies on milk production and composition of camel(Camelus dromedaries) under nomadic system.M.Sc.Thesis,University of Khartoum.

Sato, S. (1976). Preliminary report of camel ecology among Rendille in Northern Kenya. Primate Research Institute. Kyoto University, Japan.

Sawaya,W,N; J.K.Khalil; A.Al-Shalhat and H.Al Mohammad. (1984) .Chemical composition and nutritional quality of camel milk .*J. of food Science*, 49,744-747.

Schwartz, H.Jand Dioli, M. (1992). The One-humped Camel in Eastern Africa. A Pictorial Guide to Diseases, Health Care and Management. Verlag Josef Margraf Scientific Books, Weikersheim.1st Eds. Verlag Josef Margraf,Germany.

Schwartz, S.andSchwartz, H.J. (1985). Nomadic pastoralism in Kenya-still a viable production system Quarterly J. Internat.Agri. 24: 5-21.

Simenew Keskes, Mohamed Ibrahim, Tesfaye Sisay Tessema, Berhan Tamir, Fekadu Regassa, Tesfu Kassa and Fufa Dawo. (2013). Production systems and reproductive performances of *Camelus dromedarius* in Somali regional state, eastern Ethiopia. *Journal of Agriculture and Environment for International Development* - JAEID, 107 (2): 243 – 266 .

Simpckin, S.P.(1994). Traditional camel management , methods in Kenya with special refrences to milk production. In: Bonnet, P. (ed) Dromedaries and camels , milking animals(Dromedaries et chameaux, animeaux laitiers)Actes du colloque. 24-26 October 1994, Nouakchot, Mauritania, CIRAD, Montpelier, France.pp.67-78.

Spencer, P. (1973). Nomads in alliance: Symbiosis and growth among the Rendille and Samburu of Kenya, London, Oxford University Press, 230 pp.

StatSoft Inc. (2011) STATISTICA (data analysis software system), version 10. www.statsoft.com.

Sulieman.A.H; A. A.Ilayan and A. E. El-Faki. (2006). Chemical and microbilogical quality gariss. Sudanese fermented camel's milk product, International of J.of Food Science and Technology, vol. 41, page 321.

Sweet,L., E.(1965). Camel Pastoralism in North Arabia and the Minimal camping unit. In man, culture and animals., eds Leeds, .A. and Vayeds, A. Washington, AAAS(AMERICAN Association for the Advancement of Science), pp. 124-152.

Tekerli, M., Akinci Z., Dogan I. and Akcan A. (2000). Factors affecting the shape of lactation curves of Holstein cows from the Balikesir Province of Turkey. *J Dairy Sci* 83:1381–1386.Thesis, Faculty of Veterinary Medicine, University of Khartoum.

Thiagarajan,T.R. (2001). Ship of the desert. The Hindu on line edition of India's National News Paper.PP.1-3.

Wardeh, M.F.. (2004). Classification of the Dromedary Camels. *J. Camel Science*., 1: 1-7.

Waredeh, M.F. and M, Ould Al-Mustafa. (1990). Camel breed types in the Arab countries North and West Africa. In: Arab symp. Camel Husbandry and disease and methods of their control. March 24-26, 1990. Alger, Algria. ACSAD/aS9/p105/1990, Damascus.

Webb, B.H.; R.H.Johnson, and J.A.Alford (1974). Fundamental of Dairy Chemistry,

Wernery, V. (2007). Camel milk new observations. Camel conf-Book. International Camel Conference. Bikaner, India.

Wernery, V; B.F.Hanke and B.C Johnson. (2003). The effect of heat treatment on some camels milk constituents. Preliminary report. Milchwissens Chaft .58 (615): 277-279.

Williamson,G. and Payne, W.J.A. (1978).An introduction to animal husbandry in the tropics.3rd ed. London, Longman, 755 pp.

Wilson, R.T.(1984). The camel. London, Longman Group Ltd.

Wood, P. D. P.(1967). Algebraic model of the lactation curve in cattle. Nature 216:164–165.

Yagil, R. (1982). Camels and camel milk. Animal Production and Health. 26, FAO, Rome.

Yagil, R. and Z.Etzion. (1980). Effect of drought conditions on the quality of camel milk. J. of Dairy Res. 47:159-166.

YAQOOB, M. and NAWAZ, H. (2007). Potential of Pakistani camel for dairy and other uses. Animal Science Journal, 78:467–475. doi:10.1111/j.1740-0929.2007.00464.x.

Yasin, S. A. and Wahid, A. (1957). Pakistan camels. A preliminary survey. Agric. Pakist., 8: 289-297.

Zayeed, A.A; Magdub, A.B. ;Shareha, A.M. El-Sheikh, A. and Manzally, M.(1991). Camels in the Arab World. University Omar El-mukhtar, Libya. 1st Ed. (Arabic).

Appendices

QUESTIONNAIRE

Survey in Khartoum vicinity.

Questionnaire provided below:

(The farm):

1Name: ……..

2\ Location: ……..

1\ Khartoum ( ) 2\ Khartoum North ( ) 3\ Omdurman ( )

3\ Type of herding:

1\ camel only ( ) 2\ camel and cattle ( ) 3\ camel and goat ( ) 4\ all type of animals ( )

4\ Purpose of investment:

1\milk only ( ) 2\ milk and meat ( ) 3\ milk and agriculture ( ) 4\ all of the above ( )

(The owner):

1\ Name……

2\ Age:

1\ 10-20 years ( ) 2\ 20-30 years ( ) 3\30-40 years ( ) 4\ more than40 years ( )

3\ Educational level:

1\ illiterate ( ) 2\ primary ( ) 3\ intermediate ( ) 4\ secondary ( ) 5\ university ( )

6\ post graduate ( )

4\ Relationship with camel:

1\ professional ( ) 2\ amateur ( ) 3\ investor ( )

(The herd):

1\ Type of camel:

1\ pack ( ) 2\ riding ( ) 3/both

2\Breeds:

1\Bushari ( ) 2\Arabi ( ) 3\ Rshaidi ( ) 4\Anafi ( ) 5\Shukri ( ) 6\kabashi ( ) 7/kinani ( ) 8/Rofai

3\ Herd composition:

1\ lactating she camels……

2\ dry she camels……....

3\ young females……

4\ young males……..

5\ heifers……

6\ adult males…….

7\ breeder males…….

4\ Herd size:

1\ 1-10 ( ) 2\11-20 ( ) 3\21-30 ( ) 4\ 31-40 ( ) 5/41-50( ) 6/51-60( ) 7/61-70( ) 8/71-80( )

8/81-90( ) 9/91-100( ) 11/more than 100( )

(Herd men):

1\ 1-5 ( ) 2\ 6-10 ( ) 3\ more than 10 ( )

2\ Education level of herd men;

1\ illiterate ( ) 2\ educated ( )

3\ Employment:

1\ only herd man ( ) 2\ herd man and milker ( )

4\ Herd man agreement with owner:

1\ money ( ) 2\ money and animals ( ) 3\ both of the above ( )

(Milking):

1\ Milking let down stimulation:

1\presence of offspring ( ) 2\without presence of offspring ( ) 3\ both of the above ( )

2\ Milking frequency:

1\ once ( ) 2\ twice ( ) 3\ three times ( ) 4\ four times ( ) 5\more ( )

3\ Method of milking of each she-camel:

1\ one milker ( ) 2\ two milkers ( )

4\ Udder milking:

1\ all the udder ( ) 2\ half of the udder ( ) 3\ three quarters ( )

5\ Average milk yield/milking:

1\ 2 kg ( ) 2\ 3 kg ( ) 3\ 5 kg ( ) 4\ less than 2 kg ( ) 5\ more than 5 kg ( )

6\ Average milk yield/day/farm:

1\ 10-20 kg ( ) 2\ 20-30 kg ( ) 3\ 30-40 kg ( ) 4\ 40-50 kg ( ) 5/ 50-60kg( )

7/more than 60kg( )

7\ Lactation period:

1\ 6 months ( ) 2\ 8 months ( ) 3\ 10 months ( ) 4\ 12 months ( ) 5\ 14 months ( )

6\ 16 months

8\ Amount of camel milk:

1\offered to offspring……

2\ used by family……...

3\ amount sold……

9\ Camel milk products:

1\ cheese ( ) 2\ ghee ( ) 3\ soured milk ( ) 4\ non of the above ( ) 5/ice cream( )

(Nutrition):

1\ Type of feeding:

1\ pasture only ( ) 2\ pasture and concentrates ( ) 3\ green fodder ( )

4\ green fodder and pasture ( ) 5\ concentrates( ) 6/roughages( )

2\ Type of grasses in pasture:

1\...adu70..... 2\ breseem…….. 3\. Acacia seyal.....

4/Acacia nilotica...5/Balanites aegyptiaca.....

3\ Type and amount of concentrate supplement:

1/sorghum…… ٢/nut cake 3/cotton cake 4/brane 5/Gundol

(Watering):

1\ Source of drinking water:

1\ the Nile ( ) 2\ wells ( ) 3\ national water net ( ) 4\canal ( )

3\ Additives to drinking water:

1\ common salt ( ) 2\ bicarbonates ( ) 3\ common salt and bicarbonates ( )

4\ no additives ( ) 5/ molas( )

4\ Means of transportation of water:

1\ farm cart ( ) 2\ car ( ) 3\ moving of animals to water source ( )

(Housing):

1\ Type of houses:

1\ open yards ( ) 2\ fence ( ) 3\ open pen ( ) 4\ litter covered pens ( ) 5/ semi close( )

(Milk marketing):

1\ in the farm ( ) 2\ marketing centers ( ) 3\ groceries ( ) 4/ used by family( )

2\ Price of kg of milk in Sudanese pounds:

1\ 1 ( ) 2\ 1.5 ( ) 3\ 2 ( ) 4\ 2.5 ( ) 5\ 3 ( )

PLATES

Plate 1: Major Dr. Alaas Intensive Farm.

Plate 2: Major Mahjoub Intensive Farm.

Plate 3: Calving date.

Plate 4: Milk sampling and collection.

Plate 5: Calves birth weight.

Plate 6:chest girth measurement.

Plat 7: She-camel stimulationfor milking by the presence of the calf.

Arabi she camel

Plate 8: Arabi breed.

Plate 9: Anafi breed.

Plate 10: Bishari breed.