THE POTENTIAL OF CONDENSED CAMEL MILK IN CONTRIBUTING TO FOOD SECURITY IN GREATER BARAGOI, SAMBURU DISTRICT.

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DECLARATION

I, MARTIN FRANCIS KINOTI declare that this thesis is my original work, and has not been presented for a degree in any other University.

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DEDICATION

This thesis is dedicated to my parents, the late Mr. Francis Munjuri and Mrs. Stella Kambura Munjuri for their invaluable support and tremendous sacrifice.

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OPERATIONAL DEFINITIONS:

Community - The people living in the Greater Baragoi, irrespective of their ethnicity.

Diet - All forms of food eaten/consumed, including fluids.

Financial access to food - The ability of the individual to purchase food, even if it is batered.

Githeri - A cooked food mixture of maize and beans.

Greater Baragoi - All the area covered by Baragoi division prior to sub-division into the current Baragoi and Nyiro divisions.

Household - The aggregation of individuals living in one manyatta and for whose livelihood the respondent was responsible.

Household food security- Arrangements and operations that enable all members of a household to have access to a minimum level of nourishment at all times.

Manyatta - The traditional homestead of the communities living in the Greater Baragoi.

Nutritional security - The distribution of food and care in such a way that the minimum physiological requirements of the members of each household are satisfied at all times.

Physical access to food- The ability of the individual or household to reach a source of food within one hour from where they live (using the local means of transport), or having food in stock out of own production or purchasing.

Social access to food - The ability of an individual or household to utilize a certain type of food, without being inhibited by existence of food taboos or beliefs within the community.

Ugali - A cooked stiff porridge usually made from maizemeal.

Uji - A cooked thin porridge made from maizemeal or other cereal flour.

ABBREVIATIONS AND ACRONYMS

Av.	-	Average.
C.I.G.	-	Camel Improvement Group.
eq.	-	Equivalent.
FARM	-	Food and Agricultural Research Management.
H.F.S	-	Household Food Security.
I.N.Q	-	Index of Nutritional Quality.
Kcal	-	Kilocalories.
mcg	-	microgram
ME	-	Metabolizable Energy.
mg	-	Milligram.
ml	-	Millilitre.
NAD	-	Nicotinamide Adenine Dinucleotide.
NADP	-	Nicotinamide Adenine Dinucleotide Phosphate.
N-Balance	-	Nitrogen Balance.
NGO	-	Non-Governmental Organization.
NPN	-	Non-Protein Nitrogen.
NPU	-	Net Protein Utilization.
ODA	-	Overseas Development Agency.
ppm	-	parts per million.
RAA	-	Reduced Ascorbic Acid.

RDA - Recommended Daily Allowance.

RNI - Recommended Nutrient Intake.

sd - standard deviation.

ABSTRACT

This study was carried out in Baragoi and Nyiro divisions of Samburu district with the main objectives of, first, determining the financial, social and physical accessibility of both fresh and condensed camel milk to the community and, secondly, to determine the changes in the levels of specific nutrients during evaporative condensation of camel milk as well as during storage.

A total of 147 randomly selected members of camel improvement groups were interviewed using a structured questionnaire which had been previously pre-tested. Samples of fresh milk were analysed for their content of vitamin A, vitamin C, total niacin, crude protein, lactose, total fat, total ash, total carbohydrates and metabolizable energy using standard laboratory procedures. Also, samples of condensed milk were analysed immediately after condensation, and thereafter at intervals of 4 weeks during storage at room temperature, 24°C, 30°C and 35°C.

Results showed that there were no cultural beliefs or food taboos that prohibited rearing of camels or consumption of milk from them. The mean total milk consumption per household was found to be 5.2 litres per day, out of which 1.7 litres were camel milk. It was found that households owning camels had the potential to spare approximately 2.4 litres of camel milk per day, which could be condensed and accumulated for use during the drought. During these periods, households which do not own camels would have to depend on purchasing. It was, however, established that it would cost about six times more to purchase a unit of energy from condensed camel milk as it would to purchase the same unit from cereal grain.

Evaporative condensation led to loss of up to 36% of vitamin A, 22% of vitamin C and 5% of total niacin. There was also a loss of about 70% protein, 53% lactose and 6.7% total fat. The ash content, however, increased slightly during condensation. The levels of vitamin A and lactose remained stable in the first four weeks of storage, but declined in the second four weeks. Levels of vitamin C, protein, total ash and niacin remained fairly stable during storage. Moisture levels increased during the second month of storage whereas mould were noticed in the samples in the 9th week of storage. In all cases, there were no statistical differences in the changes in levels of the nutrients at different temperatures during storage. Larger changes in nutrient levels were found in the samples that had been opened for sampling in the course of storage, than those that were not, although these were not significantly different from the levels in the samples that had not been scooped from.

The findings from this study suggest that condensed camel milk could be a potential energy supplement for camel owners during prolonged dry periods. However, it would be an expensive source of energy for those who do not produce and condense their own milk. This justifies the need to encourage camel ownership in Baragoi.

CHAPTER 1

INTRODUCTION

Milk is an important part of the traditional staple diet for most pastoral communities, including the residents of Baragoi and Nyiro divisions of Samburu district, who comprise mainly of the Samburu and Turkana communities. The decline in the number of farm animals owned by individual households over the years, owing to frequent droughts has however,led to a decline in the availability of this traditional staple, meat and blood. Reliance on wild foods, such as fruits and vegetables has also declined with time due to the same reasons and the community has been forced to adopt non-traditional items of diet such as cereals and pulses to ensure survival.

During the peak production periods, sufficient milk is available in many households and is in many cases consumed as the only food item, while some of it is used for making tea. During times of scarcity some of the little milk available is used to prepare tea which is then taken in accompaniment with *ugali*. *Ugali* is also consumed in accompaniment with milk.

Although the Baragoi community rears several species of livestock, the most common being cattle, goats and camels, the ability of the camel to withstand adverse drought conditions has made it the species of choice for purposes of milk and meat production during the dry seasons (Yagil, 1982; Yagil and Etzion, 1980). Annual yield estimates show the camel as a better provider of milk in these areas than the cow, or the goat (Yagil, 1982), because the animal is able to produce milk long into the dry period even after other animals have stopped producing.

The main traditional method of preserving milk among the Samburu is fermentation. In this method, fresh milk is put in a gourd and left to stand for some time, usually a day or two. The product of this process is then eaten with *ugali* or even just drunk seperately. The main disadvantage with fermentation is that the milk so preserved does not keep for long and so would not offer a solution where the aim is to keep the milk for long periods, say several weeks

The conventional methods of preserving milk, such as refrigeration and pasteurization are either not common, or are not feasible in most parts of Samburu district, including Baragoi division. Evaporative condensation and sweetening of camel milk has been initiated, as a possible method of preservation, to help extend the shelf-life and therefore the supply of milk into the dry period, when there is a general shortage in most households. Although production of sweetened condensed milk is well documented for cows' milk, there exists little information pertaining to this product with respect to camel milk. It has however, been demonstrated using cow's milk that during evaporative condensation, biochemical reactions take place leading to losses in quality. Such information is almost unavailable in the case of camel milk.

Currently, condensation of camel milk is being practised in Samburu by a simple process that was introduced by FARM-AFRICA, a non-governmental organization involved in camel improvement activities in Samburu and Marsabit districts. The process involves mixing one part by volume of sugar to four parts by volume of milk and then heating in an open metal pan to evaporate most of the water (Field et al., 1993). The condensed milk is then filled into tin cans, fitted with lids. This product is then stored and thereafter eaten either directly or used in preparing tea. Either way, the product is scooped from the can with a spoon until it is all used up. The time taken to complete each can depends on the rate of use. It would therefore be useful to know for how long such a product would stay wholesome. It is also not known for how long the same product can keep in cans that are not scooped from.

Accessibility is an important aspect of food security. Even if a food is available locally , it is not likely to benefit the community unless it is affordable (financial access), it is within one hour's travel one way from the residence, or the specific family has sufficient stocks one month before food from the next season is ready (Physical access) and there are no inhibitions to its utilization owing to cultural aspects such as beliefs, food taboos and norms (Social access). It is not known how much fresh and condensed camel milk are accessible to the average Samburu or Turkana household, especially during the dry weather.

1.1. Statement of the Problem

The Greater Baragoi is generally arid and semi-arid, with most parts receiving less than 500mm of rainfall per year. The rainfall is bimodal, with the long rains falling in March - May and the short rains coming in October - November. When the rains come, the pastures improve and milk production increases, partly because calving synchronises with rains. There is therefore a glut of milk from all the species of livestock, including the camel. Unfortunately the rains are followed by long dry periods. This is the case especially after the long rains. Milk production therefore falls progressively as the dry weather progresses, finally leaving the camel as the only animal producing milk.

Preservation of excess milk during the periods of glut, would ensure its availability during the dry period. Although several conventional preservation methods exist, most of them would not be feasible in this area of Samburu district. FARM-AFRICA has developed a technique of condensing camel milk through open pan evaporation, but the extent of damage to nutrients during this process is not yet established. This study seeks to determine the levels of retention of some specific nutrients in the condensed product. Furthermore, certain micro-organisms enter the milk during milking, processing and possibly during handling and storage. Although the high levels of sugar are expected to inhibit growth of most of these micro-organisms, others such as mould might be able to grow under such conditions and ultimately cause spoilage of the product. This study therefore, will partly determine which particular moulds grow on the product, to enable modifications in the process and handling of the product to minimise the growth.

1.2 Justification of the Study:

Most of the species of livestock reared by the Samburu community cannot bear the heat, shortage of forage and drinking water during the hot season. Only the camel has been known to continue producing some milk (up to 4.5 litres per day) during the dry season, which lasts up to six months. During the wet period(Mar -May), the average amount of milk available to each household is approximately 300 litres (Field and Njiru, 1984), which is far in excess of the monthly requirement per household. T he households without camels get adequate supplies from shoats and cattle.

Preservation by evaporative condensation appears promising as a solution to milk shortages in the dry season. This investigation seeks to assess the extent to which condensation of camel milk can solve shortage problems during the dry period, to establish the chemical and biochemical changes that may take place during condensation, as well as establishing the shelf life of the product. It will then be possible to base any recommendation(s) of the product as a food security measure for the area on the nutritive value and the keeping quality, since these two are crucial characteristics in determining usefulness. This is relevant in that the condensed camel milk would be expected to be the principal form available to provide food security for all groups including children and the elderly, as well as pregnant and lactating mothers during the months of drought. Information generated from this investigation would be useful in planning nutritional interventions in the division and probably other marginal camel rearing areas.

Field et al.(1993) have concluded from field surveys, that condensed camel milk is acceptable to most of the households in Samburu and Marsabit districts, but it is not well documented to how many households the condensed camel milk is financially, physically and socially accessible. This investigation therefore, seeks to provide such information through a community survey. The community survey would also establish whether other factors such as food taboos and beliefs that inhibit the community against consumption of camel milk do exist.

1.3. Study Objectives

1. To determine household accessibility to condensed camel milk in Greater Baragoi.
2. To determine the level of specific nutrients in fresh camel milk and after condensation.
3. To determine the keeping quality of condensed camel milk.

1.3.1 Sub-objectives

1. To determine the physical, financial and social access of the households to condensed camel milk.
2. To determine the levels of specific nutrients in fresh camel milk.
3. To determine the level of specific nutrients in condensed camel milk.
4. To determine the levels of specific nutrients in stored condensed camel milk.
5. To determine the extent of growth of moulds and yeasts in stored condensed camel milk.

CHAPTER TWO

LITERATURE REVIEW

2.1: The Concept of Food Security:

2.1.1: Definition:

There is no simple definition of household food security, only that among those that have been suggested, some are more often cited than others. However, all the definitions are adjusted to suit the needs and priorities of individual users (Maxwell et al., 1992).

The World Bank (1986), has defined food security as access to adequate food for all people at all times. According to this definition, food security implies arrangements whereby people are assured of minimum adequate level of food grain supply in periods of normal as well as poor harvests. Food security can also be defined at rural, national, regional and international levels (Amiti, 1982). Amani, (1988) defines food security broadly as access by all people at all times to enough food for an active healthy life. This definition entails both availability of food and the ability of all members of a society to have access to adequate amounts of food. The two major elements of food security are the availability of food and the economic ability to acquire it (Diab, 1990). Food and nutrition security is defined as the ability of a household (or nation) to obtain, at all times, a dependable and adequate supply of food inorder to achieve a satisfactory level of nutritional well being (Leslie and Rankine, 1987).

2.1.2: Household food insecurity:

Household food insecurity refers to a combination of the inability to consume the desired amount of food at the individual level and food unavailability due to existence of excessive costs incurred by the economy to ensure food availability (Badiane, 1988). This is significant in that, in Greater Baragoi, not only isn't there sufficient food grain, but also food is expensive owing to the high costs incurred during transportation. Food insecurity also arises where there is general fear among the people of a certain area or region that there might not be enough to eat, based on their own experiences and knowledge of common local indicators . In Kenya for example droughts and therefore food shortages have been said to occur at intervals of about five years. Food insecurity varies from the recurrent and predictable food deficits to more severe entitlement failures, which arise from a mix of socio-economic, environmental and political factors and which at their worst could lead to famine (Corbett, 1988).

2.1.3: Indicators of access to food

A major aspect of the vulnerability to household food insecurity is the ability of the household to cope with the stress, since households are not passive to the stress (Borton and Shohan, 1991). Socio-economic indicators are sought, which represent the degree of stress being experienced by a population as economic and social conditions change and how they are responding to it

(Frankenberger, 1990). Some of the indicators of inadequate access to food include:

a) Appearance of unusually large numbers or amounts of assets, especially those that are a store of value, such as livestock in the local markets (Corbett, 1988).

b) Risk minimizing practices such as diversification of resources and enterprises as well as loss management mechanisms such as migration to look for employment (Walker, 1989).

c) A simultaneous cycle of decapitalization and wealth accumulation whereby the poorer households start to sell their livestock, pledge their farms, sell their land and labour to the wealthier households, who then buy them at deflated prices (Watts, 1983).

The concept of household access to food is in itself difficult. Even more difficult is the identification of valid and reliable indicators to measure it - not only because household access to food is determined by many different factors which depend upon food procurement pathways, production systems and local economies, but also because it is a recent concept (Mwadime and Baldwin, 1994).

Inorder to estimate the accessibility of milk in communities that have it as a major item of diet, it would be necessary to determine both the amount of milk that the households produce from their herds and that which is available from purchasing from other local suppliers. Whether or not the households can afford the milk is also a crucial factor in estimating household accessibility to it.

2.1.4 Estimating household access to food

Over 60% of the Kenyan population live in rural areas and consume largely what they produce. However, at household level, there is often a shortfall in own production yet household access to food should not be compromised provided that acceptable food is available within a reasonable distance and is affordable. An important assumption made is that those responsible for access to food have control of either the food itself or the finances to purchase it (Mwadime and Baldwin, 1994).

Causes of household food insecurity could be summarized into two variables (Mwadime and Baldwin, 1994):

a) Lack of physical access to food: In this case, food does not exist within one hour walking distance from where the household lives.

b) Lack of financial access to food: In this case the food may be physically accessible but the households' purchasing power is too low to acquire the food required.

c) A combination of (a) and (b): In which there is little food around the household and they have undesirably low purchasing power.

Tables 2.1 and 2.2 show how indicators of physical and financial household access to food respectively can be measured:

Table 2.1: Indicators of Physical Access to Food:

Is food physically Accessible within 1 hr walking distance		
YES	Yes but in reducing amounts	NO
Household food secure	High risk	household food insecure

SOURCE: Mwadime and Baldwin (1994).

Table 2.2: Indicators of Financial Accessibility of Food:

Is food financially accessible ?	Yes: families spend up to 60% of their income acquiring food
	Yes: families spend 60-100% of income acquiring food
	No: families need more than 100% of their income to acquire food

SOURCE: Mwadime and Baldwin (1994).

In rural areas where households run out of food stocks, there is usually no food available in the market for purchase; when it is available it is expensive, meaning that when the families food stocks are depleted, family purchasing power is eroded, frequently by one third or more. For pastoral communities, terms of trade could be used, such as the percentage of families who sell their cattle at prices 30% or lower than the usual values (Mwadime and Baldwin, 1994).

2.2: Livestock Ownership and Productivity in Samburu

Livestock ownership varies greatly among the pastoralists of northern Kenya, with the relatively poorer households owning no livestock at all, while the wealthier households own cattle ranging from 31 to about 63. These households also own other types of livestock, with some owning up to 400 goats (Field and Njiru, 1984). The estimated mean livestock ownership in Baragoi is 5.4 camels, 9.9 cattle and 29.7 shoats per household. The mean number of lactating animals during the dry season within Baragoi was estimated to be 1.8 camels, 0.9 cattle and no shoats (Field and Njiru, 1984).

Camel rearing among the Samburu is as a result of the influence by the Rendille in the Northern parts of the district and the Turkana in the Southwestern region, which has occurred in the past twenty years or so. Prior to this period, the community reared mainly cattle, goats and sheep.

Livestock productivity during drought is very low because of being on a sub-maintenance diet. Large scale mortality reaching up to 80% in some areas, has affected cattle, sheep and goats in most of the communities. Camels were reported to be producing milk for most of the households, but when the production figures were converted to amount of milk available per adult equivalent, they were very low (0.05 litres). In most cases, cattle and small stock provided only 33% of the milk for these communities, with the contribution from small stock being insignificant (Field and Njiru, 1984).

Cows provide much less milk than camels, except in periods when there is plenty of green pasture. Marsabit and Samburu districts were shown to have a mean daily supply per adult equivalent of 0.13kg. This, however, has an effect on the development of growing children because the little that is produced is usually used exclusively for tea (Field and Njiru, 1984).

Another possible source of nutrients is meat. However, supply of nutrients from meat at household level is difficult to estimate because the animals are slaughtered irregularly at butcheries or ceremonial occasions. In most parts of Samburu and Isiolo districts camels are so few that they are rarely slaughtered, if at all. The interval of slaughtering a camel ranged between one and six months (Field and Njiru, 1984).

Cattle, like camels are rarely slaughtered during drought, and only when they are already too weak and emaciated. On few occasions, cattle are slaughtered for ceremonial purposes, but there is very little contribution to human food from meat during drought; in contrast, small stock are slaughtered regularly ranging from one every other day to once a month per household (Field and Njiru, 1984).

Although the general assumption is that consumption of blood increases with drought, the opposite applies among the pastoralists because the animals are too weak to be bled as frequently. Moreover, there is not enough milk or fat to be mixed with the blood, and in some cases drinking of blood from live animals is prohibited. In Samburu the most commonly bled animal is the camel (Field and Njiru, 1984).

2.3: Food Consumption Patterns of the Study Community

2.3.1 Milk

Milk is the commonest weaning food in Samburu. In a study by Muita et al.(1993), 74% of the mothers used milk and porridge for weaning. Most of the mothers weaned their children before they were one year old.

The main diets among the Samburu living in the area covered by FARM-AFRICA's community based health programme are tea and *uji* (porridge) for breakfast, with a few others (6.1%) and (5.7%) reporting to have *githeri* and boiled maize respectively. The commonest diet taken for lunch was *githeri* and *uji*, and the two featured significantly for supper. The main diet for children was reported as milk and *uji*, with most households reporting that there was not enough milk for all members of the household (Muita et al., 1993).

During special periods such as pregnancy, most women (54.4%) reported that they ate any of the available food, but about 33% reported that they avoided porridge and maize. Tea and milk were not avoided by any of the interviewees (Muita et al.,1993).

During periods of drought, households depend heavily on purchased food and famine relief supplies. For some of the communities, however, especially those in areas where communication is difficult, these supplies (for sale as well as food aid) take long to reach. In South Horr for example, households were found to survive on bananas and blood (Field and Njiru, 1984).

Maize meal and sugar are readily available and are heavily purchased during drought. Each household member in Baragoi was estimated to consume about 63g of maize meal per day, which supplied about 226 Kcal of energy. Beans were estimated to provide about 27 Kcal and wheat flour about 116 Kcal of energy. Livestock products provided a total of 642 Kcal (82 Kcal from milk and 560 Kcal from shoat meat) of energy per adult equivalent (Field and Njiru, 1984). For the wealthier households in Samburu, livestock products supply a major portion of the diet in the wet season as well as a significant share in the dry season. For the medium sized holdings, the same situation applies but to a lesser extent. For the poorer households, livestock products are a relatively small part of the diet all year round, their dependence on purchased foodstuff being substantial and constant. During drought however, all categories of stock owners depend on purchased foodstuffs to meet the bulk of their dietary requirements. Livestock products are limited, and direct access to livestock may be restricted when animals, particularly cattle are led to far off grazing camps (Sperling, 1987). For example during the drought in 1984, the cattle were moved about 50-100 km away, and only the warriors manning the grazing camps had access to milk, meaning that the women, children and the elderly had no access to milk until the end of the dry season (Sperling, 1987).

Cattle are not very reliable during periods of drought because they are usually the first to die, and the pastoralists end up not benefiting in terms of food from them because they leave them until they are too weak to slaughter for food. Goats provide milk for two-thirds of the period. During the height of drought, families with 30-80 goats have access to about 0.8-1.0 litre of milk, but this falls to below 0.5 litres during the latter period of drought. Pastoralists prefer to sell the little milk available during the dry season so as to be able to purchase grain, since that way, instead of catering for only one small child for one meal, one glass of milk, once sold, is enough to provide enough maize meal for 1 to 1.5 adults. A little milk is however reserved and used for tea which is then fed to the child with some *ugali*.

Some herders are willing to bleed their small stock in the months of April-May, when there are alot of acacia pods, which are good fodder for the goats. At these times a healthy goat is bled every two to three weeks, yielding 0.5.to 1.0 litre of blood (Sperling, 1987).

2.3.2 Foraged foods:

Gathering is no longer popular among the younger generation of the Samburu people who have progressively lost the knowledge, as well as the taste for a wide range of edible wild plants which acted as diet supplement to the community in the past. It is primarily the elderly who still retain the knowledge of where to gather and how to prepare fruits, tubers and leaves from the "wild" plants (Sperling, 1987).

Hunting is more socially acceptable to the Samburu than gathering, especially among the warriors in the grazing camps. The favourite game are the gazelle and giraffe. Older men and boys trap the smaller sized animals such as the dik-dik; however, since hunting is banned in Kenya since 1977, hunting is done at legal risk and therefore majority of the Samburu prefer to procure food through commercial channels during drought (Sperling, 1987).

In the drought season, a family of six adult equivalents purchases about 10-15kg of grain per week, which, in case of drought, goes up to about 20kg. During the prolonged drought in 1984, most Samburu households complained of both lack of money and poor availability of grain in the market.

The main source of cash during the dry period is the sale of small stock. Unfortunately, due to oversupply, the prices are normally about 25-35% of the usual prices. The poorer households sold an average of 1 goat each week to be able to cover family expenses, compared to once every two months by their wealthier colleagues (Sperling, 1987). The reliance on purchased food during drought is high in Greater Baragoi. Considering that the money needed for this purpose is obtained from livestock sales, it is expected that those with more livestock available for sale would be more financially accessible to condensed camel milk.

2.5 Nutritional Status of the Community:

A standard equivalent of 2100Kcal energy and 50g protein per adult equivalent is adopted as the daily requirements (Field and Njiru, 1984). A diet is considered adequate if it can supply at least 65% of the standard for those individuals in light work (Field and Njiru, 1984). Based on the intake of energy and protein, a survey by Field and Njiru (1984), revealed that residents of Baragoi had a mean intake of 1101Kcal energy and 78g of protein per adult equivalent per day . This corresponds to an energy deficit of 44% and a surplus intake of protein of 56%.

Child malnutrition was found to be 51.3% based on weight-for-age, 49.9% with respect to height-for-age (stunting) and 32.3% with respect to weight-for-height (wasting)(Muita et al.,1993). Malnutrition was found to be highest between February and March, and between July and August.

Malnutrition among the under-fives in Samburu district is high and it gets worse during the drought (Muita et al., 1993). Results of the base line survey indicated need for community education, aimed at making households more food secure by utilizing animals that are more drought persevering and exposing them to various methods of food preservation (Muita et al., 1993). The extension programmes already initiated by FARM-AFRICA and which are aimed at popularising the camel are expected to contribute substantially towards reducing malnutrition in Greater Baragoi.

2.5 The Camel in Arid Environments

The camel belongs to the family camelidae. Within this family there are two types, namely the dromedary and the bactrian camel. The dromedary camel is also called Camelus dromedarius. Studies have indicated that the dromedary camel is the draught animal par excellence, owing to the following physiological and ecological adaptations that give it a clear advantage over other livestock species:

1) Low rate of respiration reduces water loss through the lungs.

2) Drinks less water than other livestock species and could even stay up to one month or slightly more without drinking water, without any adverse effects (Field et al., 1993).

3) Its thermolabile, able to vary its body temperature by up to 6^0 c (Schmidt - Nielson, 1964).

4) The forestomach is a dynamic reservoir.

5) It excretes very concentrated urine, through efficient kidneys.

6) It urinates on its hind legs and this helps to cool the animal through loss of latent heat.

7) Minimizes water loss by producing faecal pellets that have very little water in them.

8) The animal is able to re-cycle its nitrogen as urea.

9) Its thick eyelashes protect its eyes from the dust, especially in the dusty and windy environments (Field et al., 1993).

In Samburu, the specific variety that is mostly reared is the Turkana (a dromedary), with a few farmers rearing the Somali type of camels. Camels in Baragoi are reared for milk and meat. Although the Samburu community prefers the donkey to the camel for purposes of transport, the camel is occasionally used to transport luggage and people. It has been known to carry a load of between 150 - 300 kg depending on the distance to be covered(Field et al., 1984). The camel is also occasionally used for meat, but this is rare, with only the weakened, barren and injured animals being put to such use.

Milk is the main food obtained from the camel. In arid zones, camels are better providers of food than the cows, which are severely affected by the heat and scarcity of forage and drinking water (Yagil, 1982).

2.6 Camel Milk

Milk is unique as a balanced source of dietary needs. Only the whole carcass of an animal, including the bones and the hooves could contribute as much as milk taken as a single food. Some communities, such as the nomadic M'bororo of West Africa live for months exclusively on milk (Kon, 1972). At the height of drought, fattened animals especially those kept as drought reserve, are slaughtered and the fat and meat used for food.

Camel milk compares very closely with milk from other livestock species, except that of the buffalo and sheep, which tend to have considerably higher percentage of fat than that of the camel (Kon, 1972). Table 2.3 shows a comparison of the composition of milk from various livestock species and humans.

The variation in the composition of milk can be partly attributed to inherited capabilities of the animals but the stage of lactation, age and the number of calvings also play a role. The feeding and water quality and quantity are also of significant importance (Yagil, 1982). Reports on the composition of camel milk as well as total yields vary and the factors that influence the composition of camel milk are not very well understood. An increase of fat, protein and ash was noted in the second year of lactation (Gnan and Sheriha, 1986). Sodium and potassium showed the largest increase among the minerals. Protein content also decreases with yield.

Camel milk normally has a sweet sharp taste, but sometimes it tastes salty (Rao et al., 1970).

Like the milk of other species, the taste of camel milk depends on the amount and type of forage consumed by the animal. Certain trees, herbs and shrubs when fed to the camel make the milk salty and bitter (Knoess, 1984). Camels secrete milk with a high water, sodium, potassium, phosphate and chloride content, but low fat, protein, lactose, calcium and magnesium when water is unavailable and the daily temperatures are high (Yagil and Etzion, 1980).

The colostrum of camels has been described variously as normal white, watery , of sweet taste and thicker than cow colostrum (Ohri and Joshi, 1961). It is low in moisture, fat, potassium and lactose, but higher in total solids, proteins, albumins and globulins, calcium, magnesium, phosphate and sodium than normal camel milk (Abu-lehia et al., 1989; Rao et al,, 1970; Yagil and Etzion, 1980). It has not been possible yet to judge how soon post-partum camel milk should be processed, but 8 days, as in the regulations per cow milk is certainly too early (Wangoh, 1993).

Table 2.3: **Composition of fresh milk from various animals**

species	Moisture (%)	Total solids (%)	crude protein (%)	Fat (%)	Total Ash (%)	Lactose (%)
Cow	87.6	8.7	3.2	4.5	0.7	4.8
Buffalo	83.1	9.5	3.8	7.4	0.8	4.6
Goat	88.2	7.8	3.4	4.0	0.8	3.6
Sheep	79.5	12.0	6.7	8.5	0.9	4.3
Human	88.0	8.3	2.0	3.3	0.2	6.8
Camel	87.0	10.1	3.0	5.4	0.7	3.4

Source: Kon, (1972).

Heat processing of camel milk is not widely practised. Prolonging the shelf-life of camel milk by pasteurization or sterilization could improve food security and generate income in arid areas where camel milk is important (Wangoh, 1993).

2.7 Camel Milk as a Source of Nutrients

Proximate analysis of camel milk has been done by several scholars. Some of the results are shown in Table 2.4 below.

2.7.1 Vitamin C (Ascorbic Acid) in camel milk

The term vitamin C denotes both reduced ascorbic acid (RAA) and dehydro ascorbic acid (DHA). RAA is readily and reversibly oxidized to DHA but DHA is irreversibly oxidized to 2,3-diketogulonic acid, which has no biological activity (Bender, 1978).

Camel milk is a rich source of vitamin C and this is important because fruits and vegetables, which are the main source of the vitamin in most other areas, are lacking in the arid and semi-arid environments (Yagil, 1982).

The levels of vitamin C in camel milk are three-times the levels in cow milk and one-and-a-half times the levels in human milk (Yagil, 1982). The quantity of vitamin C in fresh camel milk has been given by Knoess (1984) as 3.6 mg per 100 ml and by Wahba et al., (1988) as 2.3 mg per 100 ml.

The requirement of vitamin C to prevent deficiency symptoms is less than 10mg/day. However, at this level of intake, wounds do not heal properly, because of the inadequacy of vitamin C for synthesis of collagen in connective tissues. An intake of 20 mg/day is required for optimum wound healing. Allowing for individual variation in requirements, this leads to an RDA for adults of 30 mg/day (Bender, 1993).

Vitamin C is one of the least stable of all vitamins and is easily destroyed during processing and storage. Exposure to prolonged heating in the presence of oxygen and exposure to light are harmful to the vitamin. Light causes rapid destruction of ascorbic acid in milk, the extent of which has been shown by de Man (1990) to be parallel to the development of off-flavours. Up to 90% of vitamin C could be destroyed in 2 hours if the milk is left exposed (Bender, 1978). Destruction of vitamin C during storage is accelerated by sucrose, fructose and fructose phosphate, leading to the formation of furfural (Bender, 1978). Ascorbic acid is oxidized in the presence of air under neutral and alkaline conditions but not at acid pH. For example in citrus juices, the vitamin is more stable on account of the low pH of the juices (de Man, 1990).

Table 2.4 Levels of some nutrients in fresh camel milk:

Nutrient	Amount
Protein (%)	2.5 - 4.5 (Av. 3.5)
Fat (%)	3.2 - 5.5 (Av. 4.3)
Lactose (%)	3.2 - 5.6 (Av. 4.4)
Ash (%)	0.6 - 1.2 (Av. 0.9)
Vitamin C (mg %)	2.3 - 3.6 (Av. 2.9)
Vitamin A (I.U)	50 - 129.1 (Av. 89.5)
Riboflavin (mg %)	0.04
Niacin (mg %)	0.46

Source: Wangoh, (1993).

While vitamin C may be stable during storage in sealed containers, especially if sulphur dioxide is present, there is a very rapid destruction as soon as the container is opened, and the vitamin comes into contact with air. Retention of vitamin C during storage depends on the storage temperatures, and the lower the temperature the less the loss (de Man, 1990).

Processing may also result in vitamin C losses from milk. Ice cream contains no vitamin C, and so does cheese. Production of powdered milk involves a 20-30% loss and evaporated milk a 50-90% loss (de Man, 1990). Pasteurization of milk results in loss of about 25% of the vitamin and about 10% of several of the B-vitamins (Bender, 1984). Ascorbic acid oxidase is one of the enzymes that may alter the level of vitamin C during storage. It's maximum activity is at 40^0 C and is almost completely inactivated at 65^0 C. Therefore, rapid heating helps to protect the vitamin (Bender, 1978). Destruction of vitamin C could occur long before processing starts, if the milk is exposed to the sunlight.

Loss of vitamin C during storage is directly proportional to the amount of oxygen present. With an oxygen concentration of 0.1 ppm, up to 20% vitamin C could be lost during storage and up to 100% with an oxygen concentration of 8 ppm. Evaporation of milk leads to loss of up to 60% of the vitamin owing to the long period of heating during the process (De Riffer, 1976).

2.7.2 Vitamin A:

Milk and milk products are an important dietary source of preformed vitamin A. Fresh camel milk contains about 129 IU of vitamin A (Sawaya et al., 1984). There is seasonal variation in the levels of vitamin A in milk and milk products, and this has particularly been traced to the kind of forage that the animal eats in different seasons.

Two groups of compounds have vitamin A activity namely Retinol (preformed vitamin A), which is found only in animal foods, and a variety of carotenes which are found in yellow, red and green vegetables. The chemical structures of both retinol and carotenoids include series of conjugated double bonds, which are highly susceptible to light catalysed oxidation. Carotenes which can be metabolized in the intestinal mucosa to yield retinol are called pro-vitamin A carotenoids, the most important being β-carotene.

Vitamin A is fairly stable to heat, it's maximum loss during cooking being about 40% (Bender, 1992). However, it is unstable in acid media (pH < 7) and stable in neutral and alkaline media. Vitamin A is relatively stable to heat in the absence of oxygen but there is significant oxidation in the presence of oxygen owing to the highly unsaturated character of the molecule (de Man, 1990). Losses may occur at high temperatures in the presence of oxygen and the vitamin is also susceptible to oxidation by lipid peroxides and conditions favouring lipid oxidation will also result in vitamin A breakdown (de Man, 1990).

Pasteurization and sterilization of milk does not result in significant loss of vitamin A, but losses may occur during storage, and are more related to duration of storage rather than storage temperature (de Man et al., 1986). The stability of vitamin A varies with the food. It is very stable for example in liver at 76^{0}C , only 0-10% is lost. Milk suffers a loss of vitamin A on exposure to light, and up to 10% has been shown to be lost after 6 hours of exposure (Bender, 1978).

Vitamin A requirements are based on the intakes required to maintain a concentration of 20mcg retinol/g in the liver. This concentration is adequate to maintain normal plasma concentration of the vitamin, and people with this level of liver reserves can be maintained on a vitamin A-free diet for many months before they develop any detectable symptoms of deficiency. The average requirement to maintain the concentration of 20mcg/g in the liver is 6.7 retinol equivalents per kilogram body weight. Children are more sensitive to vitamin A intoxication (incase of excess intake) than adults. Table 2.5 shows the recommended upper limits of habitual intake of retinol.

2.7.3 Niacin

Two compounds, nicotinic acid and nicotinamide have the biological activity of niacin. Virtually all the niacin in milk occurs in the form of nicotinamide (de Man, 1990). An assessment of the total niacin content of food includes the conversion of nicotinamide to nicotinic acid which is done by the enzyme nicotinamide diamidase from Micrococcus lysodeikticus . Camel milk contains about 0.46 mg/100 ml, of niacin (Sawaya et al.,1984).

Table 2.5: Recommended upper limits of habitual intake of retinol:

Group	Upper limit of Intake (mcg/day)	RNI (mcg/day)
Infants	900	350
1-3 years	1800	400
4-6 years	3000	500
6-12 years	4500	500
13-20 years	6000	600-700
Adult men	9000	700
Adult women	7500	600
Pregnant women	3300	700

Source: Bender,(1993).

Niacin can be synthesized in the body from the essential amino acid tryptophan. Milk is generally a poor source of tryptophan, and therefore communities which rely heavily on milk in their diets would have to depend on richer sources of preformed niacin to meet their nicotinic acid requirements (Passmore and Eastwood, 1986).

On average, 60 mg of dietary tryptophan is equivalent to 1mg of preformed niacin in the diet. Niacin equivalent therefore, denotes the sum total of the amount of preformed niacin and onesixtieth of the amount of tryptophan in the food item. The niacin in cereals is excluded (see below) when calculating the niacin equivalent because it is present in a chemically bound form (niacytin), which is not released during digestion, so that the vitamin is not biologically available (de Man, 1990).

The niacin equivalent is calculated as follows:

mg niacin equivalents = mg preformed niacin + 1/60 mg. of
(except in cereals) tryptophan

The average requirement of niacin is 6.6 mg/1000 Kcal (Bender, 1993).
Deficiency of niacin is common among those communities whose diets include substantial amounts of machine milled maize meal, as opposed to that which is pounded traditionally by women in the villages (Passmore and Eastwood, 1986).

Niacin is probably the most stable of the B-vitamins. It is stable to heat, air and light at all pH values and is not affected by sulphite, the commonest losses during processing being through milling and leaching into water(Bender, 1978). Processing of milk, such as pasteurization, sterilization, evaporation and drying have little, or no effect on nicotinic acid level. In many foods, application of heat, such as during baking or roasting increases the amount of available niacin (de Man, 1990).

2.7.4 Proteins in milk:

Milk has a protein content of about 3.6%, but this varies with the species, season and the breed of the animal (de Man, 1990). Camel milk has a protein content that ranges from 2.5%-4.9%, with a mean of 3.4% (Abdel-Rahim, 1987) and a good amino acid profile which is particularly rich in leucine and glutamic acid (de Man, 1990). The protein of cow milk can be divided into two components:

1) Casein, which consists mainly of phosphoprotein and comprise 78% of the total weight of protein.
2) Serum proteins, which make up to 17% of the total weight of protein. Up to 5% of the total protein in milk is made up of non-protein nitrogen, containing substances that include peptides and amino acids. Milk also contains very small amounts of enzymes, including peroxidase, acid phosphatase, alkaline phosphatase, Xanthine oxidase and amylase (Fox, 1982).

There is a close relationship between the protein requirement of the body, and maintenance of nitrogen-balance. The range of variation in the minimum amount of protein that must be fed in order to maintain nitrogen equilibrium lies between 21 and 65g/70 kg body weight per day. More recently, it has been found that these values have fallen, and provided it has a net protein utilization value of at least 0.7, a daily protein intake of 0.7g/kg body weight is sufficient to keep most adults in N-balance for a period of many weeks. This amount is less than what most adults eat.

Growing children need protein of a higher quality than adults. An infant grows fastest in the first three months of life, and then the daily requirement of protein is 2.4g/kg. As growth slows down, needs for protein decline, being 1.85, 1.62 and 1.44g/kg body weight per day at ages 3-6, 6-9 and 9-12 months respectively (Passmore and Eastwood, 1986).

Available evidence indicates that when damage occurs to proteins during processing of food, it is usually of little practical nutritional importance (Bender, 1978). In some cases denaturation has been known to lower bio-availability of amino acids. Protein denaturation and coagulation are aspects of heat stability which can be related to the amino acid composition and the amino acid sequence of the protein. Denaturation is a major change in protein conformation (de Man, 1990). The implication of this is that if what occurs during heat processing is only a change in structure, it is not always of negative nutritional consequence.

Processes involving high temperatures such as roasting and puffing of cereals, however, do cause damage. Lysine is the amino acid that suffers the most damage during heating of foods, but in the presence of reducing substances, other amino acids, such as cystine, and methionine can form linkages with reducing substances and are not liberated by digestive enzymes; i.e. they are rendered "biologically unavailable" (Bender, 1978).

Five types of changes occur during processing of foods; viz.

1. Upon application of mild heat, denaturation of protein does occur, but this has no effect on the nutritive value of the protein. However, physical and chemical properties, such as solubility,

viscosity, osmotic properties and electrophoretic mobility are changed. The proteins may also become more digestible.

2. Upon application of mild heat in the presence of reducing substances, linkages result between the amino group of lysine with reducing group resulting in substances which cannot be hydrolysed by digestive enzymes- this makes lysine unavailable biologically although physically present in food. These are Maillard or non-enzymatic browning reactions (Bender, 1978).

3. Severe heating reduces availability of other amino acids as well, even in the absence of reducing substances. Reactions can also take place within proteins themselves or even with intermediate products of fat oxidation (Mauron, 1976).

4. Excessive heat, such as that in roasting of foods (180-300^{0}c) leads to destruction of the amino acids by complete decomposition or by racemization and the formation of cross linkages forming poly-amino acids. D-isomers of the amino acids are not biologically active and they also have flavours different from that of L-isomers(Hayase et al., 1975).

5. Damage is also caused by alkali treatment and oxidation. Amino acids are released more slowly from damaged proteins as more nitrogenous compounds are found in the intestines. Although there is no evidence, this may imply that there is reduced nutritive value, if the amino acids are not all presented simultaneously to the sites of the protein synthesis (Carpenter and Booth, 1973).

Maillard reactions involve condensation between amino groups of amino acids and their derivatives in the protein with reducing sugars and their derivatives. The first stages of the reaction lead to formation of colourless compounds which later complex to form brown-black pigments. Maillard reactions are therefore called non-enzymatic discoloration reactions (Carpenter and Booth, 1973).

The first relatively stable compound formed in maillard reactions is 1-deoxy-2-ketose (between lysine and fructose), which is not hydrolysed by digestive enzymes, making the lysine unavailable (Hodge, 1953; Finot, 1973). Maillard reactions terminate with the formation of brown-black, nitrogenous polymers called mellanoidins. Generally lysine is the most reactive amino acid, because of the free amino group. Since lysine is the most limiting amino acid, its destruction reduces the nutritive value of proteins significantly. Foods which are rich in reducing sugars, such as milk are very reactive, which explains why lysine in milk is destroyed quite easily compared to other foods (de Man, 1990).

Blockage of lysine which occurs in the maillard reaction is non-existent in pasteurization of milk, occurs to the extent of 0-2% in UHT (ultra heat treated milk) sterilization, 10-15% in conventional sterilization and 20-50% in roller drying.

Casein heated alone is stable up to 120^0 C, while Lea and Hannan (1949) have shown that a casein-glucose mixture was unstable even at 10^0 C (Bender, 1978). The damaging effect of sucrose and other non-reducing sugars has been explained by suggesting that they are first split into reducing sugars, such as glucose and fructose after which they participate in Maillard reactions. For example, sucrose does not react with casein, but markedly increases the loss of available lysine from heated soya bean isolate (Evans and Butts, 1948). Reduction of protein quality can also occur during storage. Other effects of Maillard reactions that are of nutritional consequence include:

1. Failure to hydrolyse amino acid linkages reduces digestibility and leads to excretion of peptide fragments in faeces (Bender, 1978)

2. Some unhydrolysed peptides are absorbed in the intestines but are excreted in the urine.

3. The rate of release of amino acids from heated proteins may be delayed,thereby altering the usefulness of protein synthesis.

4. Undigested peptides in the intestines interfere with absorption of amino acids by partial inhibition of the digestive enzymes (Lee et al., 1976).

5. There have been suggestions that the products of the Maillard reactions are toxic, but the situation is not clear yet (Adrian and Fragne 1973).

Maillard reactions can make a positive contribution to food technology by producing desirable colours and flavours. Although there is some loss of amino acids when the colours and flavours are produced, this is usually small, and it is ordinarily considered a price worth paying (Bender, 1971).

From the foregoing it is evident that the effect of the process of heating on milk proteins depends on the initial amino acid structure of the protein, the environment in which it is heated, as well as the length of heating. If the process only results in denaturation, the nutritional consequence is insignificant. However, if there are Maillard reactions, digestibility may be interfered with.

2.7.5 Camel Milk Lipids:

Most camel milk fat is contained in fat globules whose average size and structure is still not certain (Wangoh, 1993). Camel milk seems similar to homogenized cow milk as it usually contains fat globules of a small size (Abu-Lehia et al., 1989). Camel milk was found to have the smallest average fat globule size among milks from five different species of animals including the cow (Knoess, 1984). Size ranges of 2.31 and 3.9 micrometers (Knoess, 1984) as well as mean diameters of 2.61 micrometers (Farah and Ruegg, 1991) and 2.9 micrometers (Wahba et al., 1983) respectively have been reported. Although fat globule diameters reported depend on the method of measurement, they are generally smaller than those for cow milk fat globules. This is significant nutritionally in that smaller globules imply faster digestion of the milk.

2.7.5.1 Effects of processing on camel milk lipids

Lipids undergo a number of degradative changes which have a much greater effect on palatability than upon their nutritional value. The nutritional value of fats is limited to the energy provision by the triglycerides and to their content of essential fatty acids. Some fats contain vitamins in solution, and it is damage to them and to the essential fatty acids that constitute any problems relating to loss of nutritional value (Bender, 1978).

Fats can readily undergo peroxidation by autoxidation, by chemical catalysis and by enzymatic catalysis with lipoxidase (lipoxygenase) present naturally or from microbial contamination. These changes take place relatively slowly, so that quality deteriorates during prolonged storage, rather than suffering any sudden loss during processing.

Oxidative and hydrolytic breakdown can spoil the flavour of a food, even when the fats are present in very small quantities. Unsaturated oils, are more liable to oxidation and may lead to unpleasant rancid flavours (Bender, 1993).

Heat treatment destroys the enzyme lipoxidase, but auto-oxidation of fat can continue even in the cold, and is the reason for quality deterioration in frozen foods containing fats, and for the potential loss of fat soluble vitamins during cold storage (Bender, 1978).

Most experimental evidence indicates no significant loss of nutritional value in normal heat processing of fatty foods, such as dairy products and eggs (Boatman, 1964). However, Vitamins such as retinol, carotenoids, cholecalciferol and tocopherols present in fats and oils undergo oxidation, while the fat itself is being oxidized (Bender, 1978). During evaporative condensation, some oxidation of fats, especially the unsaturated ones is expected to occur and with it loss of vitamin A. This is significant because milk is the major source of this vitamin in Greater Baragoi owing to a general shortage of fruits and vegetables.

2.7.6 Carbohydrates in milk

Carbohydrate in milk comprise mainly lactose (milk sugar), although in sweetened milk, other sugars such as sucrose, are present. Products of hydrolysis of the disaccharide sugars include glucose and galactose (de Man, 1990).

The principal contribution of carbohydrates of milk to the body is in the provision of energy. The amount of energy obtained from milk depends on it's Caloric density which refers to the number of kilocalories per unit weight of a specific food (Bender, 1993). Foods vary greatly in energy value, depending on the proportions of energy producing substances namely protein, carbohydrate and fat (Maltese, 1984). The energy content of food is estimated from the composition of these substances by applying the Atwater factors as follows:

Carbohydrates: 4 kcal/g

Protein: 4 kcal/g

Fat: 9 kcal/g

Alcohol: 7 kcal/g

By multiplying the amount of each of the respective nutrient by the corresponding Atwater factor, the caloric density is determined (Maltese, 1984).

2.7.6.1 Effect of processing on milk carbohydrates

The main contribution of carbohydrates during heat processing of milk is their combination with amino acid derivatives to form compounds which cannot be hydrolysed by digestive enzymes. The effect of this, is that nutrients such as amino acids become biologically unavailable. In the initial stages, the reactions between the milk carbohydrates and the amino acids lead to formation of colourless compounds , which complex later to form brown-black pigments. During the process of making sweetened condensed milk, the addition of sugar facilitates the formation of the brown pigments. At the high temperatures of condensation also, the sugar molecules lose water and form cyclic compounds which are not coloured in camel milk but polymerize to form brown-black coloured substances, the caramel. Changes from one form of carbohydrate to another, however, involve no loss and can be a gain if digestibility of the carbohydrate is increased by the treatment (Bender, 1978).

2.7.7 Minerals:

Camel milk, like other types of milk is a good source of calcium and phosphorus, and without it, children and adults would have difficulties meeting the body's mineral requirements, especially in arid environments. The mineral content of food is represented by the ash component, which is about 0.7% in fresh camel milk (Abdel Rahim, 1987).

Inorganic salts are completely stable, but can be leached out into water, although this is rare in the case of milk. The principle concern with minerals is usually the additional that may arise from the water added during processing (Schroeder, 1971). Other substances added during processing, such as sugar in the case of sweetened condensed milk may lead to an increase in the mineral content of the product hence the need to determine the ash content in this investigation.

2.8 Sweetened Condensed Milk

Sweetened condensed milk may be made from either whole milk or from skim milk. The product made from whole milk must have at least 8% fat and 28% milk solids, while that made from skim milk will have 24% milk solids and less than 0.5% fat. The main process is the reduction of water to minimize growth of micro-organism (Robinson, 1990).

2.8.1 Keeping quality of sweetened condensed milk

The keeping quality of sweetened condensed milk is largely the result of the increase in osmotic pressure (reduction in water activity) due to the binding of the water by the added sugar. The increased concentration of the milk solids brought about by the removal of water by evaporation also contributes to the increase in osmotic pressure, but this is relatively minor compared to the effect of the added sugar (Robinson, 1990).

The absence of significant amounts of air especially when the product is stored in hermetically sealed containers also contributes to the keeping quality of the product by inhibiting growth of a number of aerobic micro-organisms, particularly moulds, a few yeasts and some micrococci, which can tolerate the high osmotic pressure (Robinson, 1990).

According to Robinson (1990), the concentration of sugar-in-water of sweetened condensed milk is known as the ' sugar ratio' and it is calculated using the formula:

$$\text{sugar ratio} = \frac{\%\ \text{sugar in condensed milk}}{100 - \text{total milk solids in condensed milk}} \times 100$$

The ratio is usually 63.5-64.5 for the canned product and about 42 for the bulk, whole product; the lower level in the latter being permissible because the storage period is fairly short, and refrigeration is used.

The heat treatment to which milk is subjected should, however, not be seen as a substitute for good quality, raw milk or proper sanitation because the heat is sufficient to 'sterilize' the product, so residual organisms are always present to cause problems if the product is not handled satisfactorily. The most commonly used temperature-time combination industrially is 82-100^{0}C for 10-30 minutes, with occasional use of higher temperatures and shorter times in enclosed chambers (Robinson, 1990).

All but the most heat resistant types of organisms will be destroyed, including potential spoilage agents and hence presence of the latter in the end product is almost invariably due to contamination subsequent to forewarming. The sugar normally added is sucrose, and it can be an unimportant source of micro-organisms, but under unfavourable conditions, it may be contaminated with mould spores, osmophillic yeasts or bacteria that will produce acid and gas (Robinson, 1990).

The cans in which the milk is packed, as well as the lids should be microbicidally treated by gas flames, super-heated steam or ultra violet radiation as they could otherwise be a major source of micrococci, yeasts and moulds in sweetened condensed milk. The cans must be filled as full as possible without causing bulging as a minimum of air space plus a hermetic seal will resist the growth of the aerobic organisms that result in defects (Robinson, 1990).

2.8.2 Defects in condensed milk:

Properties of the food itself as a substrate, especially its pH influence the process of preservation. Preservatives which are non-dissociating are more independent of pH in their action and thus, they can be used in the neutral state (Ahmed et al., 1977). According to Robinson (1990), three main types of defects occur in sweetened condensed milk:

1) Gas production:- This may be caused by yeasts of the genus Torulopsis, although coliform bacteria have also been implicated where the sugar ratio is in the 40-45% range. However, since

none of these can survive the forewarming temperatures, gas production is known to mainly result from contamination during subsequent processing.

2) Thickening, which is accompanied by some acidity and cheesy odours. This is common where the sugar concentration is low, where upon micrococci and spore forming bacteria have been encountered most often .

3) Small masses of mould mycelium and coagulated casein (buttons) usually coloured white or brown may be found on the surface or the sub-surface layers of the milk. This is particularly common in canned milk because of longer storage periods. Underfilling of cans increases the oxygen available in the head space and this favours this defect. Storage below 16^0C may be helpful in reducing the incidence of this particular defect

2.9 The Principle of Evaporation:

Evaporation is the removal by evaporation of part of the solvent from a solution or dispersion of essentially non-volatile solutes. Evaporation is distinguished from crystallization and drying by the fact that the final product is a concentrated dispersion or solution, rather than precipitated solids. Many of the food products become quite viscous when concentrated. In some cases, non-Newtonian behaviour is exhibited and peculiar temperature dependence is encountered due to such effects as denaturation of protein (Karel et al., 1975).

The simultaneous extraction of water from fresh milk with the addition of cane sugar (sucrose) permits the total sugar content (including lactose) to rise to 68%. At this level bacteria no longer thrive, water is minimal and the product may be stored without refrigeration for long periods (Field et al., 1993).

2.9.1 Water activity of foods:

Water activity (a_w) is defined by Karel et al. (1975) as the ratio of partial pressure of water in the food (p) to the vapour pressure of pure water (p_0) at a given temperature. Most fresh milk does not survive long period of storage at ambient temperatures because it is a good medium for bacterial growth. Apart from the temperatures, bacteria also require water and nutrients to thrive (Field et al., 1993).

Control of the water content of the food affects the rate of the physical and chemical processes which take place in foods during storage, and therefore prolong the storage period (Karel et al., 1975). Water activity affects food stability and therefore it must be brought to a suitable level at the conclusion of drying and maintained within an acceptable range of values during storage (Duckworth, 1972).

Water activity, rather than water content determines the lower limit of available water for microbial growth. Most bacteria, do not grow below a_w =0.91 and most moulds cease to grow below a_w =0.8 . Some Xerophillic fungi have however, been reported to grow at a water activity level of 0.65, but the range of 0.70-0.75 is generally considered their lower limit. Most moulds (mycotoxigenic penicillia) have their growth inhibited by a water activity range of 0.80-0.87, particularly in most fruit juice concentrates, sweetened condensed milk, chocolate syrup, maple and fruit syrups, flour, rice, pulses containing 15-17% moisture and fruit cake (Karel et al., 1975).

2.10 pH Change in Fresh Camel Milk

Camel milk sours slowly. No change in pH was noted when the milk was kept at 30°C for 5 days, or at 4°C for 3 months (Yagil , 1982), and milk soured in 8 hours at 30°C compared to 3 hours for cow milk at the same temperature (Ohri and Joshi, 1961). Owing to this slow change in pH, the milk would therefore present less storage and transport problems in the warm climates in which it is produced. Prolonging the shelf life of camel milk by discouraging acid formation, such as by pasteurization or sterilization could improve food security and generate income in arid areas where camel milk is important (Wangoh, 1993).

2.11 Yeasts and Moulds in Milk

Yeasts are not commonly isolated from fresh milk, but there are several types which are associated with milk products. These include Debaryomyces hansenii which is isolated from cheese. The yeast which is commonly associated with sweetened condensed milk is Candida lacticondensi and does not cause fermentation of lactose (Robinson, 1990).

Several dairy products provide a rich medium for the proliferation of moulds. Cheese, for instance is associated with Geotrichum spp;, Scopulariopsis spp and Penicillium spp . Sweetened condensed milk is associated with Sporendonema sebi , which "round up" and are released when mature. Spores of fungi can be very resistant to heat and could remain viable even after boiling for many hours. Boiling even to evaporate is suitable for disinfection but not for sterilization (Robinson, 1990).

Growth of moulds and yeasts leads to spoilage of milk, such that its use as food may pose the risk of aflatoxin poisoning. Growth of yeasts also leads to spoilage by fermentation and gas production in condensed milk (Muller and Tobin, 1980).

2.12 Some Issues of Concern Regarding Camel Milk:

2.12.1 Storage stability of condensed milk

The shelf life of condensed camel milk appears to depend on factors such as the water content, the amount of air with the closed can, the level of hygiene and handling of the milk (Field et al., 1993). When these factors are controlled condensed milk may be kept for up to 6 months at room temperature (Field et al., 1993).

In an unpublished paper by Field et al.,(1993), it is reported that once the container is opened, further contamination may be introduced, and therefore it is advisable, once the tin is opened, to finish the contents without undue delay. Further, it is reported that the shelf-life of condensed milk is therefore appreciably longer than that of fermented milk and soft cheese, but probably not as long as that of hard cheese and dried milks. It is a purpose of this study therefore, to investigate these reports further.

2.12.2 Portability of fresh camel milk:

One problem encountered by pastrolists is their limited capacity to carry household effects and food when they move from one place to another in search of forage and water (Field et al., 1993). It would be difficult to carry all the extra milk in the fresh form, due to the bulkiness and the means of transport, which is mainly donkeys.

When the milk is condensed, about 70% of the overall weight is reduced. To make one kg of condensed milk, the following ingredients are required (Field et al., 1993).

fresh camel milk = 2.67 kgs

(kgs = litres)

cane sugar = 0.67 kg

Total weight = 3.34 kg

Since during evaporation no loss of the sugar occurs, it means that the 2.67 litres of milk is reduced to 0.33kg, which represents a loss of 87.6% through the evaporation of water. This implies that a pastrolist with an extra 300 litres of milk has only 110 kg of condensed milk to carry which would require at most two (2) donkeys to transport. This is a more realistic proposition. Furthermore, the high sugar levels would be useful in boosting the energy content of the diets (Field et al., 1993).

2.12.3 Palatability/acceptability of condensed camel milk:

Condensed camel milk is highly palatable; infact its so popular with children that "it probably beats the main purpose of being a means to postpone consumption" (Field et al., 1993). Among adults the only persons who may not like it are those with traditional aversion to camels, slimmers, diabetics and people with lactose intolerance (Field et al.,1993). Condensed milk may be consumed in different ways and the most popular is to dissolve it in strong tea. It may also be spread on bread or mixed with porridge (Field et al., 1993).

2.12.4 Cost of production of condensed camel milk

The condensation of camel milk has so far been undertaken by FARM-AFRICA on their ranch at Mugwooni, 30 km North-west of Nanyuki, in Kenya. The lactating camels are of the Somali and Pakistani breeds and the condensation of the milk is done on a routine basis by an employee at the camp.

The condensed milk is made daily over an open fire using an ordinary iron pan and other basic utensils. Table 2.6 shows the cost analysis for condensation of camel milk, as done at Mugwooni ranch, Kenya - February 1994. The budget below, however, cannot be applied directly to a pastrolist family and the following considerations should be included (Field et al., 1993):

1) Cost of milk: Under pastrolist conditions, the opportunity cost of the milk to be used could be zero because during periods of excess milk production, not all the milk could be sold and so it would be misleading to base the opportunity cost on the farm gate prices, since the market isn't always available. The alternative could be to throw away the milk, but this is most unlikely. It could be given to poor neighbours and thereby create allegiance or it could be given to the calf which is then grown for meat production (Field et al., 1993)

2) The cost of labour: The Mugwooni ranch project operates on a concession basis, by the kilograms of condensed milk made. The concessionaire is supplied with camp equipment, utensils, milk and sugar, but is expected to collect firewood. The current concessionaire finds the undertaking financially attractive, provided that she is supplied with at least 12 kgs of fresh camel milk, which would be enough for at least 4.5 kgs of condensed milk, and earn her some kshs. 112.50 per day.

The value of labour in a pastrolist family would depend on who was doing the condensing. If they could be gainfully employed in alternative activities, labour spent in condensing milk would need to be valued at its opportunity cost, that is its value in the next most profitable activity (ODA, 1988). The task of condensing milk is not difficult, but tedious. It would be an ideal activity for an older lady, no longer involved in raising children (Field et al., 1993).

Table 2.6: Processing Costs in Kenya Shillings per kilogram of Condensed Milk.

ITEM	UNIT	NO.OF UNITS (litres)	COST PER UNIT (ksh)	COST (ksh)	% OF TOTAL COST
Fresh milk	litre	2.67	20.00[a]	53.40	48.5
Sugar	kg	0.67	38.00	25.45	23.10
Labour	unit	1	25.00[b]	25.00	22.70
Fuel wood	kg	1	0.00[c]	0.00	0.00
Equipment	unit	1	1.13[d]	1.13	1.0
Container	unit	1	5.00	5.00	4.6

Total processing cost 109.98
99.98%

NB. 1KSh=0.017 US dollar.

[SOURCE: Field et al., 1993].

Notes:

a. Marketing cost of milk at farm gate, Nanyuki

b. Payment made to concessionaire per kg of condensed milk made

c. Fuel is cut for free on the ranch and labour is included in b

d. Depreciation on cooking and camping equipment

3) Cost of wood fuel: For a pastoralist in a fuel scarce area this item of the budget could be of significant importance; if purchased, it would probably be time consuming and keep women and children from other activities important to the family. For financial and for ecological reasons, fuel should be a highly valued resource, and this could make condensation less preferable to other methods, such as fermentation in areas of extreme desert situation. In less extreme areas, camels browse woodlands far from settlements where ample dead firewood is available (Field et al., 1993).

CHAPTER 3

DESCRIPTION OF THE STUDY SETTING

3.1: Location of the Study Area:

This study was carried out in the Baragoi and Nyiro divisions of Samburu district of the Rift Valley province of Kenya. The district consists of six divisions. Baragoi and Nyiro divisions resulted from the sub-division of the former Baragoi division, which for purposes of this study will be referred to as the Greater Baragoi. Baragoi division has 4 locations and 11 sublocations whereas Nyiro division has 6 locations and 12 sublocations. Samburu district borders Marsabit district to the North, Turkana to the North West, Baringo to the South West, Laikipia to the South and Isiolo to the South East. Baragoi and Nyiro divisions together cover an area of 7,300 km^2.

3.2: The Climate of Greater Baragoi

Baragoi and Nyiro divisions are mainly arid and semi-arid areas, with an average anual rainfall of 510mm (Range 364 - 719). The short rains come in October to November (occasionally they stretch into December) and the long rains usually come in the period March - May. The temperatures range between $22^{0}C$ - $33^{0}C$ (District Dev. Plan 1994-1996).

3.3: The People of Greater Baragoi:

The greater Baragoi division is inhabited by two major communities, the Samburu and the Turkana. The Samburu occupy mainly the areas around Baragoi shopping centre, Barsaloi, Latakweny, South Horr, Arsim, Lesirkan and Tuum. The Turkanas mainly occupy the area around Baragoi shopping centre, Nachola, Charda and Tuum. The other tribes present in the division in small numbers are the Ariaal Rendille and the Gabra in the North Western parts of the division.

According to information given in the District Development Plan for Samburu district (1994-1996), the populations of Nyiro and Baragoi divisions in the year 1994 was estimated to be 21,706 and 17,655 people respectively. These projections were based on 1979 census data. The population growth rate of Baragoi was estimated to be 3.7%.

The main local languages spoken are Samburu and Turkana, with a few of the inhabitants being able to communicate in both languages. For this study an interpreter who could speak both languages was hired.

3.4: Social Structure:

There is a strong traditional social structure within the community of Greater Baragoi. The households are almost exclusively headed by men (except where the women are widowed).

Information concerning the family units and their property is almost secret. It can only be divulged to persons known to the community, and even then, only reservedly. The respondents for this study were the male household heads and the widowed ladies. Wherever the interviewer only encountered the wives in the manyatta, he was always referred to the male head of the household. This shows the firm, established line of authority in the households.

3.5: Demographic Information on Samburu

According to a survey conducted by Field and Njiru (1984), the number of people per household varied from around 4 in the Gabbra inhabited parts of Samburu district to 14 in the predominantly Samburu inhabited areas of Wamba and Baragoi. A factor of 0.75 was used to convert the juveniles to adult equivalents for ease of comparison. The mean adult equivalents per household for Baragoi was 9.0.

Up to 96% of the community in Samburu had no basic education (Muita et al., 1993). The main occupation for men is herding of livestock, whereas women combine herding and housekeeping.

3.6: Infrastructure in Greater Baragoi

3.6.1 Roads:

The Greater Baragoi has no tarmac road. The main graded road runs from Merti through Baragoi centre and proceeds to Tuum and South Horr. The roads to Arsim, Latakweny and Barsaloi are not graded, and this makes public transport to those areas quite unreliable. The main shopping centres in the division, which are connected by a murram road network are Merti, Baragoi, South Horr and Tuum. These are very useful particularly for the distribution of food stuffs. Other active shopping centres in the division are Barsaloi and Latakweny.

3.6.2 Water

Water is a major limiting resource in the division. There is no piped water in most parts of the division except around the shopping centres at Tuum, Arsim and Barsaloi. There are a few boreholes in the division but these are currently not useful because either the water from them is salty or they need rehabilitation.

Majority of the residents of Baragoi depend on water from rivers for both domestic use and for animals. These rivers are however often very far from the manyattas .

3.6.3 Health facilities

The Greater Baragoi has one major Health Centre at Baragoi shopping center and dispensaries operated by missionaries at Lesirkan, Barsaloi and Tuum. Residents who require major treatment travel to Maralal district hospital, approximately 117km from Baragoi.

3.7: Economic Activities:

Most of the people are engaged in small scale farming activities as subsistence self-employed farmers. Production of crops is far below the requirements of the division and so most of the food (grain, potatoes etc) has to come from outside (District Development Plan, 1994-1996).

Pastoralism is the main economic activity of the residents of Baragoi and Nyiro divisions. The traditional system of nomadic pastoralism still exists. More recently however, pastoralists are increasingly settling permanently or semi-permanently as a result of intervention activities of the government, donors and NGOs in developing agriculture, business, communication, water sources and other services in the division.

The 1989-1993 Samburu district development plan estimated the number of people supported by livestock to be 75% of the entire population, and nothing appears to have happened to significantly change this position (Samburu District Dev. Plan, 1994-1996).

3.8: Camel Milk in Greater Baragoi:

Farm-Africa has undertaken the task of mobilizing the pastoralists of this community to form camel improvement groups (CIG's). These are self-help groups which usually have memberships of 15 - 45 persons, with an average of 30. The purpose of the camel improvement groups is to create a forum where the development agency (in this case FARM) can:

a) Encourage the members through training to improve the husbandry of their livestock. Although the emphasis is on camels, other species of livestock are also attended to.

b) Encourage the groups to appoint some people among themselves who are then given training on basic drug handling and administration so that they can work as drug handlers to give basic treatment to the herds.

c) Give the members some cash advances, to enable them start some money generating activities and training these members on basic principles of managing small business. Some of the activities undertaken by these CIG's include livestock trade, hides and skins trade and small retail shops.

Camel improvement groups are registered social groups with elected officials to oversee their day to day running. Members meet at least once a month (or whenever there is need). Membership in CIG's is open for both men and women (although culturally, unless widowed, the meetings are attended by the men). The members of CIG's do not all own camels, but most of them do, and those who do not, intend to buy the camels in future. During CIG meetings, the development education team from FARM-AFRICA attends, and the members, apart from discussing the problems they might have with their herds and businesses, they also give progress reports and returns.

CHAPTER 4

MATERIALS AND METHODS

Introduction

This study was carried out in two parts: Community survey to determine the accessibility of condensed camel milk to the community, and laboratory analyses of fresh and condensed camel milk for some specific nutrients.

4.1: Community Survey

A descriptive survey was carried out by interviewing a random sample of 147 members of camel improvement groups in Baragoi and Nyiro divisions. The interviews were conducted using a structured questionnaire which had been previously pretested.

4.1.1 Choosing the study site

Baragoi division was chosen for the study because:

a) The camel is popular for milk production among the members of the Samburu and Turkana communities who form the majority in the division.

b) Rainfall is not reliable in the division and this exposes the residents to risks of frequent shortages of food.

c) FARM-AFRICA has already sensitized the community on camel milk production and preservation by condensation. They have also conducted demonstrations to members of camel improvement groups in the division.

d) Condensed camel milk has been sold within the division on a trial basis in the past, making it possible to get consumers' opinion on the product acceptability.

4.1.2: Familiarization with the study area:

In order to understand the administrative boundaries, environmental conditions, infrastructural layout and the organization of camel improvement groups, a familiarization tour of all the locations was made. A visit to each of the locations to be covered in this study was organized through the development education team of FARM, to coincide with the camel improvement group meetings. During the visits, informal discussions were held with some members of the groups and also with the development education team of FARM. During such discussions questions that were to be covered in the main interviews were not asked.

4.1.3: Sample size determination:

The minimum sample size for the community survey was calculated using the formula by Fisher et al. (1991) as follows:

$$n = \frac{z^2 . p. q.}{d^2}$$

where:

n = minimum sample size.

z = the standard normal deviate set at 1.96 for a confidence level of 95%.

p = the proportion of the community estimated to have at least physical access to milk out of own production, based on livestock production and management data, which was estimated to be 0.8.

q = the proportion of the community estimated not to have physical access to milk out of own production, which was estimated to be 0.2.

d = the level of accuracy, set at 0.1.

Therefore minimum sample size:

$$n = \frac{(1.96)^2 \times (0.8) \times 0.2}{(0.1)^2}$$

= 62 respondents.

Assuming a non-completion rate of 20%, an additional 12 respondents were added to the sample, such that the desired minimum sample size became 74.

The level of accuracy was set at 0.1 because:

a) It was presumed difficult to achieve a higher degree of accuracy due to the respondents' reluctance to report the exact number of animals owned as this is culturally unacceptable.

b) The respondents have not experienced a serious food shortage since 1990, because there has been a regular supply of food aid. This meant that the number of animals that had to be sold in order to cope with the drought was under-reported or unknown. Further, the food aid received was not accurately reported.

The non-completion rate was estimated at 20% to cater for the difficulty in tracing the members of the camel improvement groups between one meeting and the next as they often travelled outside their residential areas to perform various business and social functions.

4.1.4: Sampling the community:

Sampling was done in two stages. The first stage was purposive sampling which was carried out to isolate those locations which had active camel improvement groups (CIG's). The membership of each CIG was also determined.

The second stage was proportionate random sampling of the members within each CIG, based on the minimum sample size. Table 4.1 below shows the membership of the camel improvement groups, the minimum sub-sample from each group and the number of respondents interviewed in the group, while Figure 4.1 shows the summary of the sampling procedure used.

4.1.5: Pretesting of the survey tool:

The questionnaire was pretested by interviewing 15 respondents picked at random from the division. Any necessary modifications in the questionnaire were made before its use in the actual survey. The questionnaire pre-testing was also used as training for the research assistant.

4.1.6: Actual survey:

The actual interviewing of CIG members started on the first week of February 1995 and lasted for a total period of 3 months, up to the end of May 1995.

Most of the respondents were reached at their monthly CIG meetings and others by visiting their manyattas. The respondents mostly spoke their vernacular and a few could understand and speak Kiswahili. The interviews were therefore conducted in Kiswahili, Samburu and Turkana languages and when necessary with the help of an interpreter.

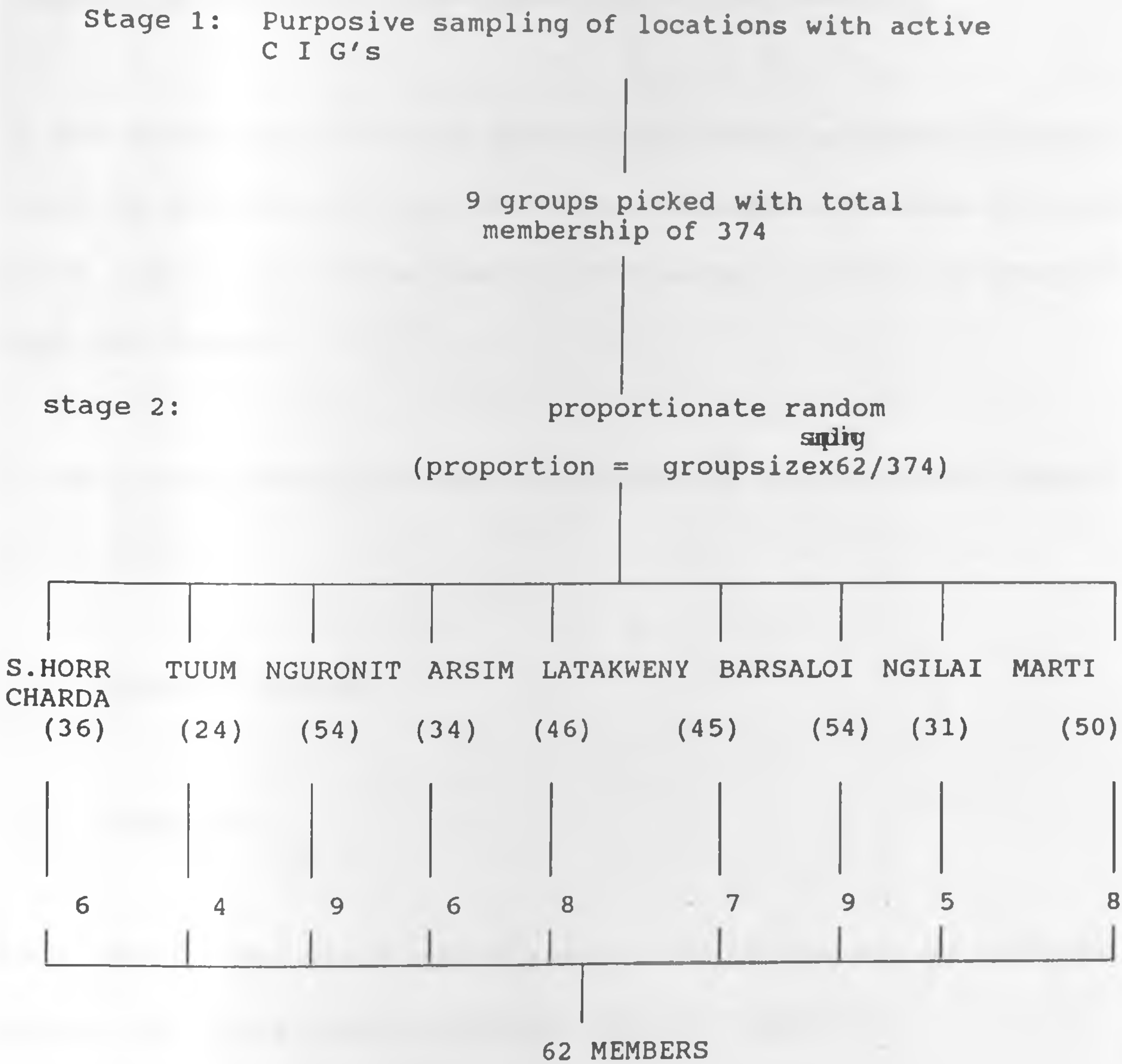
4.1.7: Cleaning, entry and analysis of data:

The questionnaires were cleaned for any wrong entries and other obvious mistakes at the end of each day, by both the principal investigator and the research assistant. Data was entered using the SPSS/PC+ programme and one-way-within-subjects analysis of variance and students' t-tests were carried out.

Table 4.1: Names, locations, membership and samples of respondents from the camel improvement groups in Baragoi and Nyiro divisions.

Location	Group name	Membership of group	Target no. of members	Interviewed
South Horr	South Horr	36	6	16
Tuum	Koskosi	24	4	8
Nguronit	Mao	54	9	20
Arsim	Sidai	34	6	16
Latakweny	Lchoro	46	8	24
Barsaloi	Looningo	45	7	17
Ngilai	Lomunyak	54	9	19
Marti	Loimayana	31	5	12
Charda	Charda	50	8	15
Total		374	62	147

Fig. 4.1: Summary of the sampling of CIG Members:



4.1.8: Problems encountered:

i) The communities living in Baragoi and Nyiro divisions have a strong traditional set up and strictly observe most cultural beliefs, some of which prohibit declaration of one's wealth. This tended to lower the accuracy of the information obtained, especially on livestock ownership.

ii) Many of the respondents did not speak or understand Kiswahili, which necessitated use of an interpreter with the possibility of some questions being not clearly understood.

iii) Most members of the CIG's were not easy to trace between one meeting and the next, because they often travelled far from their homesteads to transact various businesses. This meant that the respondents could only be traced during CIG meetings and therefore the survey took longer than anticipated.

iv) Assay of some nutrients such as lysine and riboflavin could not be accomplished because of lack of facilities.

4.2: Analytical Methods:

4.2.1: Chemicals:

All the chemicals used were of analytical grade and were purchased from Sigma Chemical company. Any aqueous solutions were prepared using glass-distilled water.

4.2.2: Sampling of condensed camel milk for storage and analysis:

Sixteen (16) samples of 300g each of condensed camel milk, prepared from the same batch of milk, by the same concessionaire were randomly divided into four different groups and stored at 24^0C, 30^0C, 35^0C and room temperature at Baragoi (control). From each group and temperature, samples of approximately 2g were scooped from three of the tins at intervals of 4 weeks. The fourth tin in each group tin was not scooped from, until the end of the storage period when its contents were analyzed. At each time, the milk samples were analyzed for moisture and total solids, pH, crude protein, total fat, total ash, vitamin A, vitamin C, total niacin and lactose. Total carbohydrate and metabolizable energy were calculated by difference. A sample of fresh milk obtained before condensation was analyzed likewise. During storage, the samples were also inspected for any visible signs of growth of moulds and yeasts, crystallization and development of odours.

4.2.3 Diluting the condensed milk for analyses:

Each sample of condensed milk was dissolved as required in boiling-hot distilled water to the desired dilution and cooled immediately to about 25^0C.

4.2.4: Determination of moisture content and total solids:

Moisture content of the sample was determined by the method of the International Dairy Federation (IDF, 1963), as described by Ronald and Ronald(1991). Five grams of condensed milk were accurately weighed in a watch glass which had been dried to constant weight, then placed in an oven set at 105^0C and left overnight. The watch glass and the sample were then cooled in a desiccator and weighed. The difference in weight represented the amount of water lost. This was then expressed as percent moisture content based on the weight of the sample. Percent Total solids was calculated as a difference between 100% and the percent moisture content.

4.2.5: Determination of pH:

The pH values of both fresh and condensed milk were determined by the method of the International Dairy Federation (IDF, 1963), as described by Ronald and Ronald,(1991).

To determine the pH of fresh camel milk, 20ml were placed in a beaker that had been cleaned and rinsed with distilled water. The temperature of the milk was adjusted to 24^0C and the pH determined with a PW 9420 pH meter.

To determine the pH of the condensed milk, 10g of sample were dissolved in 10ml of boiling-hot distilled water, the temperature adjusted to 24^0C and the pH determined using a PW 9420 pH meter.

4.2.6: Determination of crude protein:

Protein content was determined by the method of Lowry et al.(1951).

Reagents:

1) Reagent A: 2g NaOH, 10g Na_2CO_3 and 0.1g Na-K tartarate dissolved in 500ml distilled water.

2) Reagent B: 0.5g $CuSO_4.5H_2O$ in 100ml of distilled water.

3) Reagent C: 100ml of Reagent A and 2.0ml of Reagent B mixed just prior to use.

4) Reagent D: Folin Ciocalteu phenol reagent (stock) prepared by mixing 1 part by volume of the reagent with 2 parts by volume of distilled water.

One-millilitre of diluted milk (250mcg of milk/ml of distilled water) was pipetted into a test-tube and 5ml of reagent C added, then mixed thoroughly. The mixture was allowed to stand for ten minutes at room temperature. A quantity of 0.5 ml of reagent D was added, mixed immediately and allowed to stand for 30 minutes at room temperature, after which absorbance was read at 750nm. The percent protein content was calculated from a standard curve prepared using Bovine Serum Albumin.

4.2.7: Determination of free fat content:

The fat content of the condensed milk was determined by direct extraction with chloroform as described by Ronald and Ronald (1991) with the modification where methanol was excluded. Two- grams of condensed milk were dissolved in 50ml of boiling-hot water and stirred until it became homogeneous. Twenty- millilitres of the diluted milk were then pipetted into a reagent bottle and 40ml of chloroform added. The mixture was shaken thoroughly and left to stand overnight so that the aqueous layer and the chloroform layer separated. Ten-millilitres of the chloroform layer were transferred into a beaker which had been dried to constant weight and the chloroform evaporated away at 70^{0}C. The beaker with the residue was weighed and the difference between this weight and the weight of the empty beaker was calculated as percent fat content. The fat content of the fresh milk was determined without dilution.

4.2.8: Determination of total ash:

Total ash content of the milk was determined as outlined by Ronald and Ronald(1991). Five grams of sample were placed in a crucible which had been dried in an oven to constant weight. The sample was first dried in an oven set at 105^{0}C for 2 hours to expel most of the moisture. The crucible with the sample was then transferred to a muffle furnace set at 550^{0}C and incinerated for 4 hours. The ash was calculated as a percent of the initial weight of the sample.

4.2.9: Determination of vitamin A:

Vitamin A was determined by the method of Paterson and Wiggins (1954), as described by Varley (1988). Into 4ml diluted condensed milk (20mg condensed milk/ml of hot water), 8ml of absolute ethanol were added, followed by 8mls of heptane. The mixture was shaken and allowed to separate for 20 minutes. Three millilitres of the upper (Heptane) layer were transferred into a 3cc cuvette and the absorbance read at 327nm using a Beckman SP 1800 spectrometer. The sample was then transferred into a Bijou bottle and stoppered. This was subjected to UV radiation for 3 hours after which absorbance was read again at the same wavelength. The difference between the two readings was used to calculate the concentration of vitamin A in the sample using a vitamin A solution containing 20mcg pure retinol palmitate/10ml heptane as a standard.

4.2.10: Determination of vitamin C (Ascorbic acid)

Vitamin C was determined as reduced Ascorbic Acid by titration with 2,6-dichlorophenolindophenol (Varley, 1988). Into 4ml of diluted milk (2g/100ml hot water), 4mls of 10% Trichloroacetic acid were added and mixed . The mixture was then centrifuged at 900G for 5 minutes using a Fischer G18 centrifuge. The supernatant was quantitatively pipetted out and titrated against 0.2ml of 2,6-dichlorophenolindophenol solution (80mcg/ml) until the reddish colour was discharged. The volume of the titre was then taken. The Vitamin C content was calculated as mg/100ml as follows:

$$\text{mg. Ascorbic Acid per 100ml} = \frac{100\text{x } 2 \text{ x } 0.008}{\text{vol. of titre}} = \frac{1.6}{\text{vol. of titre.}}$$

4.2.11: Determination of total niacin:

Total niacin was determined colorimetrically after reaction with chloramine-T and potassium cyanide by a modified method of Carlson (1966), as described by Njagi (1990). One-hundred-fifty milligrams of freeze dried Micrococcus Lysodeikticus powder (Sigma Chemical Co.) were suspended in 5ml Kreb's-Ringer phosphate-bicarbonate buffer and 0.5ml of this suspension was added to 2.5ml of the milk sample (made by dissolving 2g of condensed milk into 100ml of boiling-hot distilled water). After incubation at 37°C for 20 minutes, the reaction was stopped by placing the tubes in a boiling water bath for 2 minutes. After cooling to about 24°C, 6ml acetone were added and the denatured protein and insoluble buffer salts were removed by centrifugation at 600G for 10 minutes. Acetone was removed by addition of 2ml chloroform. Then 2.5ml portions of the aqueous phase were mixed with 0.8ml Chloramine-T solution (50g/litre) and 0.8ml potassium cyanide solution (10mg/ml in 60mg Tris and 175 microlitres 1mmol hydrochloric acid). After standing at room temperature for 15 minutes, the absorbance was read at 410nm. The total niacin content of the sample was then calculated using a solution of pure nicotinic acid as a standard.

4.2.12: Determination of lactose:

The Lactose content of the condensed milk was determined by the method of Varley (1988), using Benedict's quantitative solution. Twenty millilitres of diluted milk (2g/100ml hot water) were pipetted into a 100ml volumetric flask. Twelve millilitres of 10% sodium tungstate solution were added followed by 12ml of 0.67N sulphuric acid. The mixture was shaken for a few minutes and the volume made to the mark with water and then filtered. The filtrate was titrated against 25ml of boiling quantitative Benedicts' solution into which 3g of sodium carbonate had been added, until the blue colour disappeared and a white precipitate was formed at the bottom.

Calculation: 25ml of Benedicts' solution are reduced by 67mg of lactose. The lactose content was expressed as a percentage.

4.2.13: Determination of Total carbohydrate:

The percent total carbohydrate was determined by difference as follows:

$$\% \text{ Total Carbohydrate} = \% \text{ Total solids} - (\% \text{ Fat} + \% \text{ Protein} + \% \text{ Ash})$$

4.2.14: Determination of metabolizable energy:

Metabolizable energy was obtained by calculation using the method of Southgate and Durnin (1970), from total carbohydrate, fat and protein, using Atwater factors.

4.2.15: Culturing of yeasts and moulds:

Moulds and yeasts were cultured on a medium prepared by the method of Galloway and Burgess (1952). Ten grams of malt extract agar powder were suspended in 200ml of distilled water and boiled to dissolve. The medium was then sterilized in an autoclave at 115^{0}C for 10 minutes. After cooling to 55^{0}C, the pH was adjusted to 3.5 by adding 4ml of 10% lactic acid solution.

The moulds and yeasts were cultured by streaking on this medium as follows:

The medium was poured into sterile plates and allowed to set. The plates were dried at 55^0C for 15 minutes , and then streaked on the surface and incubated at 25^0C for 5 days. Identification of the moulds was done by staining with cotton blue in lactophenol and observing under the microscope.

CHAPTER 5

RESULTS

INTRODUCTION

These results are presented in two parts: The first part represents results of the community survey, through interviews. The second part represents results of laboratory analyses of fresh, condensed and stored sweetened condensed camel milk for some specific nutrients.

5.1 COMMUNITY SURVEY

5.1.1 Socio-economic Information

The following socio-economic data were obtained:

5.1.1.1 Household size

The mean household size among the 147 households covered was 12.7 composed of 8.2 children and 4.5 adults. Based on a factor of 0.75, this gave an adult equivalent number per household of 10.7.

5.1.1.2 Economic activities

Of the respondents, 81.6% were not formally employed and depended entirely on farm income for livelihood. However, most of the farm income was from livestock. A total of 87.1% of the respondents reported not growing any crops at all.

5.1.1.3 Livestock sales

Livestock sales were common, with 74.1% of the respondents reporting that they sold some of their animals during the dry period. Mean livestock sales per household are shown on Table 5.1 below.

Table 5.1: Livestock sales per household during drought

Species	Number sold during drought	Equivalent number of livestock units *
Cattle	1.4 (3.3)**	0.98
Goats	5.6 (11)	0.56
Sheep	1.2 (2.7)	0.12
Camels	0.1 (0.4)	0.1

* Livestock equivalent values used were: Cattle = 0.7, Camels = 1, Goats = 0.1, Sheep = 0.1

** Figures in parenthesis represent the standard deviations.

Note: The large standard deviation values arise from the fact that within each C.I.G, livestock ownership, and ultimately the number of animals sold during the dry season showed a big variation, with some members owning only a few sheep and goats(with hardly any cattle) while other members owned large herds of cattle and shoats. In any case, the common interest that had brought these otherwise different people(in terms of livestock resources) was the promotion of camel rearing by FARM-AFRICA. The same applies to other parameters measured, and which showed large values of standard deviation.

Majority of the respondents (74.1%), reported that they were reluctant to sell their animals, even during periods of drought. However, others (23.9%) reported that they did not sell animals even when they were threatened by drought for the following reasons, in decreasing order of importance:

1) Fear of being unable to restock.

2) Prestige attached to owning livestock by the community.

3) Lack of banking facilities, so that animals are used as cash reserve.

5.1.1.4 Movement of animals during drought

Majority of the respondents (93.2%) reported moving their animals during drought periods. The donkey is the animal used as a mode of transport for luggage by the Samburu and Turkana communities.

5.1.2 Cultural Beliefs

Cultural beliefs pertaining to the following were reported:

5.1.2.1 Rearing of camels

Of the respondents, 98.6% reported that there were no cultural beliefs that prohibited rearing of camels.

5.1.2.2 Drinking of camel milk

Of the persons interviewed 98.6% reported that there were no cultural beliefs which prohibited drinking of camel milk, except by:

1) Those suffering from yellow fever (64.1%), since it is beliefed that camel milk aggravates the sickness and the patient could easily die.

2) Those whose epiglottis had been cut (22.6%). It is believed within the community that cutting of the epiglottis prevents excessive coughing.

3) Women who had delivered a baby in the recent past (11.9%). It is believed that drinking of camel milk could lead to development of worms in the foetus.

5.1.2.3 Special preference for camel milk

Of the total number of respondents, 81.7% reported no special preference for camel milk to other types of milk. Only 10.3% reported preferring camel milk for the following reasons:

1) Camel milk is thicker than other milks, so it can be used to make more tea (7%)

(2) Tea made from camel milk is generally more delicious (2.2%).

(3) Camel milk is better appreciated in social gatherings (1.1%).

5.1.3 Livestock Ownership, Milk Production and Milk Consumption:

The mean number of each species of livestock owned by the respondents was reported as shown in Table 5.2. Livestock ownership was highest with respect to sheep and goats, followed by cattle and then camels. However, when converted into livestock units, cattle ownership was highest, followed by that of camels.

The mean number of lactating animals, the mean yield per animal and the amount of milk available per household were reported as shown in Table 5.3.

Table 5.2: Livestock ownership per household

Species	Number	Equivalent livestock Units
Cattle	11.1 (15.7)	7.77
Goats	40.4 (56.7)	4.04
Sheep	14.9 (20.8)	1.49
Camels	5.8 (11.7)	5.80

Table 5.3: Milk production data per household/day.

Species	Number of lactating animals	Yield Per animal (kg)	Milk available to the household (kg)
Cattle	3.4 (6.4)	0.8 (0.7)	2.4 (5.6)
Goats	11.6 (16.4)	0.2 (0.1)	1.6 (2.8)
Sheep	4.6 (7.4)	0.2 (0.2)	0.6 (1.5)
Camels	1.2 (1.9)	1.6 (0.9)	1.7 (3.3)

The mean milk production per camel during periods of ample pasture was 3.5 litres/day.

5.1.4 Milk Consumption:

The mean milk consumption per household was 5.2 (sd. 8.4) litres. Mean milk consumption within camel improvement groups is shown in Table 5.4. Mean household milk consumption was highest in Latakweny (10.8 litres per household), followed by Nguronit (6.1 litres) and Ngilai (5.9 litres). The mean milk consumption among other camel improvement groups ranged between 1.8_4.3 litres per household

Table 5.4: Milk consumption per household per day

Group	Daily Milk Consumption Per Household (kg)
Latakweny	10.8 (14.5)
Tuum	4.1 (6.1)
Charda	1.8 (4.4)
Barsaloi	3.3 (3.9)
Marti	4.3 (3.9)
Nguronit	6.1 (5.1)
South Horr	3.3 (2.5)
Arsim	4.1 (4.5)
Ngilai	5.9 (11.4)

5.1.5 Left-over Camel Milk

Of the total respondents, 54.2% reported having had some left-over camel milk each day during the wet seasons, but only 6.2% reported having had some left-over milk during the dry seasons. The mean amount of camel milk left-over when there was adequate pasture was 2.4 litres per household per day.

Majority (72.1%) of the respondents indicated having preserved the left-over milk for future use, 17% gave it to neighbours, 5% sold it, while 5% poured it out.

The preferred method of preservation indicated was fermentation (87.1%), for the following reasons:

(1) It was the only method known (46.3%).

(2) The product of fermentation was popular as a food item (40.8%).

5.1.6 Exchange of Camel Milk With other Food Items

Of the respondents, 86.6% indicated not having exchanged camel milk with other food items, 11.6% had exchanged some camel milk for maize flour, sugar or tea leaves. All the respondents indicated that the commonest form of exchange was that of milk with cash.

5.1.7 Food Procurement

Both the employed and unemployed bought some food in the month preceding the interview, as is shown in Table 5.5. The mean amount of cereals purchased for the month was 29.1 kg(17.5). Also, 66.7% of the respondents indicated having received some form of food aid in the period of one month preceding the interview. The mean amount of food aid received was 19.7 kg (30.6) per household.

Only 17% of the respondents were employed but majority (84%) of them purchased food. Majority (71.7%) of the unemployed received food aid. Only 38.3% of the unemployed reported having bought some food in the month preceding the interview.

Table 5.5: Food purchased or received as aid by the employed and unemployed in the month preceding the interview.

Employment status	Percent of households buying food	Percent of households receiving food aid
Employed (n=25)	84	40
Unemployed (n=122)	38.3	71.7

5.1.8 Acceptability of Condensed Milk Among the Population

Of the respondents, 60.5% indicated having tasted condensed camel milk, out of whom 87.6% indicated the milk having been very delicious. All the respondents indicated that the condensed milk was at least acceptable.

Up to 68.5% of the respondents had tasted condensed camel milk during demonstrations by FARM-AFRICA, and 11.2% had purchased the milk at least once for home use. A small proportion (6.7%) of the respondents reported having made their own condensed camel milk.

Of the respondents, 75.1% reported having observed condensed camel milk being made, whereas 58.5% indicated having knowledge of how to make the condensed milk.

Only 6.8% of the total respondents reported that they knew of a place where condensed camel milk was sold. Out of all the respondents, 97.3% indicated willingness to purchase condensed camel milk if it was available in the shops.

5.2 LEVELS OF SPECIFIC NUTRIENTS IN CAMEL MILK

Laboratory analyses of camel milk was done in stages, the initial stage being the analysis of fresh camel milk, from which the condensed milk was prepared. The freshly prepared condensed milk was then analyzed to determine the extent of any changes in the levels of the selected nutrients resulting from the condensation process as shown in Table 5.7. The condensed milk was stored at different temperatures (24°C, 30°C, 35°C and a control) and analysed every four weeks for any changes in the nutrient levels during storage.

5.2.1. Nutrient Content of Fresh Camel Milk

The nutrient contents of fresh camel milk were as shown in Table 5.6. The Table also shows the extent of change in the levels of the nutrients during condensation. The total solids content of the milk was found to be about 15%. This figure was calculated directly from the data on moisture content.

Table 5.6: Nutrient content of fresh camel milk:

Nutrient	Content
Vitamin A (mcg.Retinol eq./100ml)	50.9
Vitamin C (mg. Reduced Ascorbic Acid/100ml)	2.9 (0.3)
Total Niacin (mg/100ml)	0.6 (0.1)
Lactose (%)	2.4 (0.1)
Fat (%)	5.7 (0.1)
Crude Protein (%)	3.0 (0.2)
Ash (%)	0.8 (0.2)
Moisture (%)	84.9 (0.8)
Estimated metabolizable energy (Kcal/100ml)	85.7

5.2.2. pH of Fresh Camel Milk

The pH of the fresh camel milk was 6.6 (0.01). This shows that camel milk is slightly acidic.

5.2.3 Nutrient Contents of Condensed Camel Milk

The nutrient levels in the condensed camel milk were as shown in

Table 5.7. The changes in nutrient levels arising from the process of condensation are also

indicated. All the specific nutrients showed a decrease except for the total ash content which showed a slight increase.

Table 5.7: Composition of freshly prepared condensed camel milk

Nutrient and Units	Content	Change arising from condensation
Vitamin A (ug Retinol eq./g)	0.9 (0.2)	Loss of 36% of the Retinol
Vitamin C (mg RAA/100g)	6.0 (1.0)	Loss of 22.1% of Reduced Ascorbic Acid
Total Niacin (ug/g)	15.2 (1.2)	Loss of 5% of total Niacin.
Lactose (%)	3.1 (0.2)	Loss of 53.1% of the Lactose
Free Fat (%)	14.3 (1.2)	Loss of 6.7% of the free fat.
Protein (%)	2.4 (0.1)	Loss of 70% of the protein.
Ash (%)	11.7 (2.3)	Increase in the Ash content
Moisture (%)	13.9 (0.8)	
Estimated metabolizable energy (Kcal/100g)	369.1	

Note: These losses were calculated on the basis of liquid milk equivalent

5.2.4 Nutrient Retention During Storage of Condensed Camel Milk

Composition of condensed camel milk during storage

Storage Period	Temp.	VIT.A mcg Ret.eq./g	VIT.C (mg RAA/100g	Total Niacin (mcg/g)	Total Lactose (%)	Free fat (%)	Protein (%)	Total Ash (%)	Moisture (%)	ME (KCal./100g)	pH
0 WEEKS	-	0.90 (0.2)	6.0 (1.0)	15.2 (1.2)	3.1 (0.2)	14.3 (1.2)	2.4 (0.1)	11.7 (1.3)	13.9 (0.8)	369.1	7.10
4 WEEKS	24°C	0.84[a] (0.4)	5.0 (0.4)	15.8 (0.8)	3.1 (0.2)	14.3 (1.2)	2.0 (0.2)	11.6 (1.3)	13.7 (0.8)	369	7.10
	30°C	0.81 (0.36)	5.0 (0.8)	14.2 (1.1)	3.1 (0.2)	14.3	2.2 (0.2)	11.5 (0.7)	13.8 (1.1)	362	7.10
	35°C	1.05 (0.33)	5.0 (0.5)	14.6 (1.3)	3.1 (0.2)	14.0	2.1 (0.2)	11.8 (0.7)	13.0 (1.1)	377	7.10
	Control	0.96 (0.06)	4.0 (0.1)	15.3 0.2	3.0 (0.1)	14.8 (1.3)	2.3 (0.1)	11.7 (0.8)	13.6 (1.3)	367	7.20
8 WEEKS	24°C	0.14 (0.06)	5.0 (0.5)	14.8 (0.3)	1.7 (0.1)	13.9 (0.7)	2.0 (0.3)	10.3 (0.8)	18.3 (1.5)	354	7.01
	30°C	0.16 (0.8)	5.0 (0.5)	14.9 (0.1)	1.6 (0.6)	14.8 (0.3)	2.3 (1.8)	10.1 (2.9)	16.3	356	7.02
	35°C	0.18 (0.07)	4.0 (0.1)	14.3 (0.3)	1.5 (0.04)	15.8 (1.1)	2.2 (0.3)	10.6 (0.8)	16.1 (1.5)	329	7.10
	Control	0.18 (0.05)	5.0 (0.2)	15.6 (0.5)	1.7 (0.1)	13.8 (1.8)	2.2 (0.4)	11.6 (0.1)	17.6 (2.1)	342	7.10
16 WEEKS	24°C	0.18	6.0	14.8	2.3	13.5	2.1	11.6	13.0	363	6.70
	[c]30°C	-	-	-	-	-	-	-	-	-	-
	35°C	0.17	6.0	13.7	2.6	13.5	2.1	11.4	13.5	355	6.72
	Control	0.25	6.0	13.4	2.3	14.6	2.2	11.5	13.0	355	6.71

The figures in parenthesis indicate the standard deviation

By the sixteenth week, only the samples which had not been scooped from did not have any growth of mould, and there were the only ones that were analysed.

All the four samples at 30°C had mouldy growth before the 16th week, and therefore no analysis was carried out.

The retention of specific nutrients during storage of condensed camel milk are shown in Table 5.8. Vitamin A retention did not change significantly during the first four weeks of storage at 24°C, 30°C, 35°C and room temperature. However, there were significant losses of the vitamin after 8 weeks of storage at all the temperatures. There were however, no significant differences between the amounts of the vitamin in samples stored at 24°C, 30°C, 35°C and room temperature. There was also a significant loss of the vitamin from the samples after 16 weeks of storage.

The amount of vitamin C remained stable through out the storage period, and there was no significant difference between the levels of the vitamin at 24°C, 30°C, 35°C and room temperature. A similar trend was observed for total niacin, free fat and protein. Total ash also did not change significantly through out the storage period.

Lactose levels in the milk remained stable at all the storage temperatures during the first four weeks. However, the levels fell significantly during the second month of storage. The loss of lactose was higher in samples that had been scooped from, than those that had not.

5.2.5 Growth of Moulds and Yeasts During Storage

Mould and yeasts grew on the samples at different times as shown in Table 5.9. There was no growth of moulds on the sweetened condensed camel milk stored at 24°C, 30°C, 35°C and room temperature in the first eight weeks. However, half of the samples stored at 24°C and 30°C had grown moulds by the end of the ninth week. There was no growth observed in the samples stored at 35°C by the end of the ninth week, but three of them had mould by the end of the tenth week of storage. All the samples stored at 24°C, 30°C, 35°C and room temperature, and which had been scooped from had mould by the end of the tenth week. At 30°C, even the sample that had not been scooped from was found to have mould growth at the end of eleven weeks.

Table 5.9: Growth of moulds in the samples:

Storage Temperature	Cumulative Number of samples with mould		
	Week 9	Week 10	Week 11
24°C	2	3	3
30°C	2	3	4
35°C	0	3	3
Control	1	3	3

In all cases, mould growth (identified as <u>Aspergillus spp</u>) was noticed on the samples earlier than yeast growth.

Due to the appearance of mould in all the samples from which analysis samples had been scooped by the 11th week, no analyses were done at the end of the 12th week, and only the fourth sample (which had not been sampled from) stored at the temperatures of 24^{0}C, 35^{0}C and room temperature were analyzed in each case at the end of the 16 weeks storage period. The fourth sample stored at 30^{0}C had also grown mould by the end of the 11th week.

CHAPTER 6

DISCUSSION OF RESULTS

The main purpose of carrying out this investigation was to ascertain both availability and accessibility of camel milk to the community, while at the same time establishing the contribution that both the fresh and the condensed camel milk is likely to make in supplementing the diets of the people of Greater Baragoi. This investigation was meant to demonstrate the practical significance of condensation of milk and the possible potential of condensed milk as an item of food security for the community of Greater Baragoi.

6.1 COMMUNITY SURVEY

6.1.1 Socio-Economic Information

The household size of 12.7, and which translated to an adult equivalent of 10.7, revealed that among the communities living in Baragoi, most households had more adults than would have been expected. This would indicate a possibility of extended families where such as aunties, uncles and grand parents live in the household. This adds to the burden of providing food, especially during periods of shortage. The finding in this study is comparable to that by Njiru and Field (1984), who found the mean household size to be 9.0 adult equivalents. Considering that the mean amount of milk available to a household during drought from all the species of livestock was about 1.2 kg (Njiru and Field, 1984), such size of household is a risk factor to food shortage or inadequacy.

The fact that 81.6% of respondents were unemployed, means that the majority depended on livestock for livelihood because only 12.9% reported being engaged in any form of crop production activity. This fact is exemplified by the finding that 74.1% of the respondents indicated having to sell animals in order to be able to purchase food during drought. Although fear of being unable to restock was identified as the main reason for not selling animals even when they were threatened by drought, on average each family sold 1.4 cattle, 5.6 goats, 1.2 sheep (majority preferred to slaughter them for fat) and 0.1 camels to be able to buy some grain during the dry period (Table 5.1). Prestige was also indicated as the main reason for delaying the sale of animals during the drought even when death was imminent. According to Sperling (1987), the effect of the reluctance to sell the livestock is that by the time the owners give up on the animals' chances of survival, the animals are already too weak and too emaciated to be eaten. This could be attributed to lack of market information which the respondents indicated as the fourth most important deterrent to livestock sales during drought.

Culturally, the Samburu community attaches a lot of value and prestige to livestock ownership. This explains why during drought, they preferred to give the little milk available to the kids, lambs and calves to drinking it themselves. It also explains why, when the drought is very severe, they slaughter the young ones to give their mothers a better chance of survival (Njiru and Field, 1984).

Majority of the people who own livestock move their animals to places far away to look for water and pasture during the dry period. In Baragoi, 93.2% reported that they had moved their animals in the previous dry period. The fact that the main species moved were cattle, goats and sheep means that camels are left nearer the homes, since they are less susceptible to water and forage inadequacy. Camel milk is therefore available to those who are left in the manyattas, while the warriors who in most cases are the ones who send the other animals to grazing camps, have access to the little milk available from these animals in these camps. These results agree with the finding by Sperling (1987). The women, children and the elderly left behind in the manyattas in which camels are owned, only get milk through buying from their colleagues who own camels, or they simply stay without if they cannot afford it. The old tradition of people moving with their families when animals are being moved is less common today. Most of the families have almost permanent manyattas where the rest of the members of the family are left when the morans move the animals away in search of pasture. Camels are, however, not moved around in this manner. The implication of this change in lifestyle is that if a household managed to have some extra camel milk, it is more likely to benefit the family members left behind in the manyattas. This could be either the milk condensed during the period of abundant pasture, or it could be the little milk produced by the camels, if the family has any, during the period of scarce pasture.

6.1.2 Culture Versus Camel Rearing

The majority of the respondents (98.6%) reported that there were no cultural beliefs that prohibit the rearing of camels. This is significant in that the camel improvement sensitization programme currently being undertaken by FARM-AFRICA is unlikely to encounter cultural barriers. The main inhibition to camel ownership will remain, as indicated, the cost of purchasing the animals. Camel rearing has a long standing tradition among the Turkana people, who have interacted and passed on the practice to the Samburu community. Baragoi division is inhabited by both of these communities and it would be expected that with time, more Samburu people will take up camel rearing, especially since the cow has proved to be unreliable for milk production in the dry season (Sperling, 1987).

6.1.3 Livestock Ownership and Productivity

The pattern of livestock ownership among the respondents (Table 5.2) was comparable to the findings by Njiru and Field (1984), with some households owning very many animals and others having very few. This condition arose mainly from the drought of 1990, during which many households lost their animals and have not been able to restock adequately since then. However, all the respondents owned at least one animal. The fairly large values of standard deviation in each case is an indication of the skewness of the ownership of the animals. In some cases, it was found that some members only owned the animals (mostly small stock) given to them by FARM-AFRICA, through the Restocking Programme.

There was a difference of about 3.5 livestock units between the employed and the unemployed respondents, who owned an equivalent of 22.6 and 19.1 livestock units respectively. This, and the fact that the employed members have a regular income even during drought, exposes this group to less risk of food shortage. Infact it gives the group added financial advantage when it comes to purchasing both grain and milk. Assuming that each livestock unit (the equivalent of one camel) is sold for about KSh.5,000/- during drought or just before, it gives households with heads who are employed a head start of about KShs.17,500/-.

There was no significant difference ($p<0.05$) in livestock ownership among different camel improvement groups. However, a difference of one livestock unit in a pastoralist set up during drought could make a difference between life and death, because it determines who can afford to purchase grain for a few extra days!

The productivity of the animals was generally low (Table 5.3) and it became even lower during prolonged dry periods. In such period the cow produced an average of 0.1 litres of milk and the small stock ceased to produce milk altogether. The camel, however, shows resilience and maintains production at about 1.2 litres of milk per day. Since at this time other animals are away in grazing camps, only camel milk is available to the households and this milk has to be shared, although priority is usually given to the infants.

When good pasture is available, there is a mean excess production of 2.4 litres of milk per day over and above the usual family's mean requirement of about 5.2 litres. If the households were sensitized to hold the excess 2.4 litres as camel milk only, this could be condensed and preserved for future use.

The most preferred method of preservation of excess milk for future use was fermentation (81.1%). The limitation with this method was that the product only lasts between 2-3 days. The fact that 46.3% of the respondents using fermentation as a method of preservation indicated that there was no alternative or better method known to them suggests that if the community were sensitized and trained they could probably adopt condensation as an alternative method of milk preservation, particularly if they are convinced that it affords longer shelf-life than fermentation.

6.1.4 Camel Milk Consumption

Culturally any member of the household is allowed to drink camel milk, except in what the community considers to be sub-clinical or clinical conditions, such as when one is coughing. This ailment has traditionally been treated by cutting the epigilotis and it is beliefed that people who have been treated in this manner get worse if they drink camel milk. Although there was no known medical evidence of this, it is beliefed that worm infestation can result from consumption of fresh camel milk. Beliefs such as these could probably be countered through nutrition and health education. Since women and children are the main groups left behind when morans move livestock (except camels) in search of pasture, they would be the main beneficiaries from condensed camel milk, especially since women tend to avoid porridge and maize during pregnancy (Muita et al. 1993).

Preference of camel milk over other types of milk was low (10.3%), but it was reported that camel milk has some attributes such as being thicker and giving more delicious tea, which indicated its slightly better acceptability. Of the respondents who had tasted condensed camel milk, 87.6% said it was very delicious and none said it was unacceptable. The implication of this is that programmes that are aimed at popularising the camel are likely to be adopted without much resistance from the community.

6.1.5 Awareness About Condensed Camel milk

Although 70.1% of the respondents reported having seen condensed camel milk mainly during workshops and seminars, only 58.5% indicated having known how to make the milk on their own. Demonstrations were usually conducted during workshops and seminars, but so far this has been restricted to members of camel improvement groups. Since even some households which have none of their members in the groups own camels, it would be necessary to extend the technology of condensation to the non CIG members if the whole community were to benefit from this method of preservation.

Only 6.8% of the respondents knew of a place where condensed camel milk was sold, although 97.3% indicated that they would be willing to buy the condensed milk if it was made available in the shops. Considering the long distances between the manyattas and the shopping centres, there is better potential of utilizing condensed milk if the households are encouraged to make it in their own homes and those who do it, to sell it to their neighbours who may not have their own.

6.1.6 Purchasing of Food

Since only about 12.9% of the respondents engaged in growing of crops, the majority depended heavily on purchased grain among both the employed and unemployed groups (see Table 5.5). Food aid is also a major supplement to people's food needs in the area, with 66.7% of them reporting that they had received some food aid, in the month preceding the interview.

The fact that the employed members have some regular income, as well as owning, on average, 3.1 livestock units more than the unemployed members offers a possible explanation why less of the employed received food aid and less of the unemployed purchased food. When the two groups are compared in terms of household size, however, there was no significant difference ($P < 0.05$) between them detected, meaning that the average household food requirements are more or less the same.

When there is plenty of milk in most of the households during the wet season, the mean milk consumption per adult equivalent is about 0.48 litres per day. This amounts to a contribution of about 15% of the energy requirements to the household. Most of the households depend on maize as a staple and each would therefore require about 6.4 kg per day to achieve full energy requirement. Considering that the total amount of cereal available from both buying and food aid is about 48.8 kg per month, there is still a deficit of about 59% in the energy requirements of the households. This finding is higher than that of Njiru and Field (1984), which was 44%. This could be because the latter report was based on data collected in an urban setting, (Baragoi town) where residents were better off financially than their counterparts in rural Baragoi. Moreover, people living around shopping centres also depend on other animal products such as meat, which may reduce their energy deficit further.

For the people who own camels and produce their own milk, being able to preserve the extra 2.4 litres of the fresh camel milk would give them about 0.89 kg of condensed camel milk per day for a period of about one month after the end of the rains. For those producing their own milk, the cost of condensing the milk is KShs.33.80 per kilogram, being mainly the cost of sugar. The opportunity cost of the extra milk, as well as the cost of labour would be zero if the condensation is done at home by one of the household members who might not be alternatively employed (Field et al. 1993).

From informal discussions with members of CIG's, it was established that on average, a family would require about 400g (equivalent to 40 spoonfuls of the condensed camel milk) to prepare tea for all members of the household for a day, especially when they have to use tea as an accompaniment for *Ugali*.

Condensed camel milk provides about 369.1 Kcal/100g (Table 5.7). The condensed camel milk used for making tea therefore, would supply an equivalent of about 135.5 Kcal per adult equivalent in the household. Since the condensation of the extra milk was done over approximately 2 months, then a household could utilize the condensed product at this rate (assuming the children do not eat it as candy) for approximately 120 days. Over this period, the condensed milk contributes approximately 6.4% of the energy requirements of the family, and the balance would still have to be met through purchase of grain. Even more grain would be required after the condensed milk runs out at the end of the fourth month, if the dry period continued. Usually, other survival strategies would already have been adopted, such as reducing the intake of food or some members of the household moving out to seek wage employment (Sperling, 1987).

In order to meet the deficit in the daily energy requirement (2100 Kcal per adult equivalent) of the households that produce condensed milk, each household needs to purchase about 5.9 kg of maize per day. Most households depend on livestock sales, with each household selling on average 1.4 cattle, 5.6 goats 1.2 sheep and 0.1 camels. During adverse weather, livestock prices are 25-35% of the usual (Sperling, 1987), meaning that on average a household has KShs.11,420/= to spread over the drought period. At an average price of KShs.15/= per kilogramme of maize, a household can buy grain supplies for about four months.

It has been reported by Field and Njiru, (1984) that during the periods of drought, however, livestock available for sale is limited due to reluctance to sell them for fear of inability to restock, and the common strategy is to reduce the intake of food to as little as 226 Kcal per adult equivalent from maize meal.

Households which do not produce their own condensed camel milk would have to buy, either from their neighbours if they have excess, or from shops if the milk is available there.

However, the cost of purchasing 0.4 kg of condensed milk, was found to be KSh43.90, while purchasing the same amount of energy from maize would cost KSh6.20. In view of this difference in cost per unit of energy, most households that do not produce their own condensed milk would be better advised to purchase grain, instead of the milk to meet energy requirements.

6.2 LABORATORY ANALYSIS

The purpose of undertaking the analysis of the fresh camel milk was to obtain a reference, in order to estimate the extent of any damage to nutrients that may occur during the process of condensation. The results obtained (see Table 5.7) were comparable to those obtained by Sawaya et al. (1984), Abulehia (1989) and Abdel-Rahim (1987). Differences in the composition of fresh camel milk are mainly due to variation in pasture and forage composition as well as seasonal variation and stage of lactation. Other important factors are inherited capabilities of the animal(s), age and number of calvings (Yagil, 1992).

The process of evaporative condensation as is currently being undertaken by FARM-AFRICA involves subjecting the fresh camel milk to heat for periods of time that are not standardized. Therefore, the results obtained might differ due to the following:

i) The size of the pan: Since the process is expected to be adopted at household level, each household could have different sizes of pans and spread of the heat, and therefore length of heating would be different in each individual case.

ii) Intensity of the fire: Firewood is the source of fuel for undertaking the condensation and the types of wood used by different people differ in heat capacities, hence the heat intensity.

iii) Individual's judgement of when the product is ready: Estimation of the length of time taken up to when the milk is considered adequately condensed by evaporation is subjective, with some processors being more likely to expose the milk to heating for a longer time than others.

6.2.1 Moisture Content

Fresh camel milk was found to contain an average of 84.9% moisture, which was comparable to the values obtained by Abdel-Rahim (1987), Abu-Lehia (1989), and Farah and Regg (1989) of 87.4%, 88.7% and 87.8% respectively. During evaporative condensation, the amount of moisture was reduced to 13.9% (see Table 5.7). Along with the reduction of water content, sugar was added to the milk, reaching a sugar ratio of about 67%.

According to Robinson (1990), the sugar ratio is an indication of the concentration of sugar-in-water of the condensed milk and it is usually 63.5 - 64.5 for the canned product meant for storage over long periods and lower for the bulk packaged product which is not meant to be stored for long periods of time. It would therefore be expected that, if there was no post-processing microbial contamination, the high sugar ratio would help lengthen the storage period of the condensed camel milk by increasing the osmotic pressure (reduction in water activity) through binding of the water by the added sugar.

The moisture content of the condensed stored samples remained unchanged during the first 4 weeks of storage. There was no significant difference among the moisture contents of the samples at different temperatures ($P<0.05$).

The moisture content increased significantly during the second month of storage ($P<0.05$). Most probably the moisture was absorbed from the atmosphere when the samples were opened to scoop for analysis owing to the high hygroscopicity of the sugar. The increase in moisture would therefore most probably not take place if the samples remained closed through out the period of storage.
In the home setting however, it is more practical to expect the containers of condensed milk to be opened regularly.

6.2.2 Vitamin A

Fresh camel milk was found to contain 50.9mcg retinol equivalent per 100ml. This was comparable to the value obtained by Sawaya et al.(1984) of 42.6mcg and by Wahba et al.(1988), of 50mcg retinol equivalents per 100ml. It has been reported that the level of Vitamin A in milk is influenced by the forage eaten by the animal (Yagil, 1992).

Vitamin A is easily destroyed by exposure to sunlight. This would occur to some extent in fresh milk if the camels are milked in the open and if the milk was left uncovered for some time in the open.

During condensation, a loss of about 36% of the vitamin occurred. Condensation is carried out in the open and some of the vitamin could have broken down owing to exposure to sunlight. The highest loss however occurs during heating. Although vitamin A is fairly stable to heat, losses of up to 40% due to heating of milk have been reported (Bender, 1992). There is also significant oxidation in the presence of oxygen owing to the highly unsaturated character of the molecule (de Man, 1990).

The pH of fresh camel milk was found to be 6.6. This slight acidity could have further contributed to the breakdown of vitamin A as the vitamin has been reported to be unstable in acid media (Bender, 1992).

The level of vitamin A in the condensed camel milk did not change significantly ($p<0.05$) during the first month of storage. There was no significant difference between samples stored at the temperatures of 24°C, 30°C, 35°C, and room temperature ($P<0.05$) in terms of loss of vitamin A. This could be explained by the fact that breakdown of the vitamin during storage is more related to storage period than storage temperature as has been reported by de Man et al.(1986). Further, the samples remained closed to sunlight during the storage.

The level of vitamin A fell by about 80% between the 4th and 8th week of storage. This was probably due to oxidation by lipid peroxides, and also because conditions that favour lipid oxidation, such as opening of the can during storage, tend to accelerate breakdown of the vitamin (de Man, 1990).

The contribution of fresh camel milk to the vitamin A requirements of the households could be significant since there is very little reliance on vegetables among the pastoralists. The main source of vitamin A therefore is milk and milk products. It was established that the mean milk consumption per household was 5.2 litres. This means that there were some households which did not have access to any milk at all, or had very little milk which they mainly used to make tea. Such households would be exposed to risk of vitamin A deficiency.

By consuming an average of 0.48 litres of milk, each adult equivalent has access to about 244.3 mcg Retinol equivalents per day, which is approximately 35% of the recommended daily intake (RDI). Households which produce and choose to preserve some camel milk would have access to about 31.9 mcg retinol equivalents per day, contributing approximately 4.6% of the RDI. Households which don't produce, and therefore cannot preserve any of the milk are at an even greater risk of suffering vitamin A deficiency during the dry weather. In each of the circumstances, the vitamin A intake among the community appears inadequate, since the only other item consumed by most people is cereals, particularly maize which is a poor source of vitamin A.

6.2.3 Changes in Vitamin C:

Fresh camel milk was found to contain 2.9 mg reduced ascorbic acid per 100 ml. This value is about 3 times the level found in cow milk and 1.5 times the level found in human milk (Yagil, 1982). The value is comparable to values obtained by Knoess (1988) of 3.6mg/100ml and by

Wahba et al. (1988) of 2.3mg/100ml.

Vitamin C is one of the least stable vitamins, especially during heat processing and storage. The level of the vitamin in condensed camel milk was 6mg/100g which represented a retention of 77.9% from the fresh milk. Camel milk is slightly acidic (pH6.6) and this could be the reason why the vitamin appeared to be more stable than would have been expected. In citrus juice for example, which is more acidic than camel milk, losses of about 20-30% are known to occur during processing (de Man, 1990). In the production of evaporated cow's milk, losses of about 50-90% occur (Bender, 1992).

The levels of vitamin C remained fairly stable during storage, and there was no significant difference in the levels of the vitamin at different temperatures ($p<0.05$). There was also no significant difference in the level of the vitamin after 4 and 8 weeks of storage ($p<0.05$). Considering that the condensed milk has a slightly alkaline pH (about 7.1), the level of vitamin C would have been expected to decline at least at the higher storage temperatures. Further investigation needs to be done to establish whether there is a stabilizing factor in the condensed milk as well as the possibility of some protection through lack of penetration of the product by aerial oxygen - otherwise, the vitamin would break down rapidly when the containers are opened during storage, and faster at higher temperature than at low temperature (de Man, 1990).

The contribution of milk to the vitamin C requirements is higher in those households with access to camel milk since the other types of milk are poor sources of the vitamin. Most of the households have little or no access to fruits and vegetables, which are the major dietary sources of the vitamin in agricultural communities. By consuming about 0.16 litres of camel milk per adult equivalent, the community has a per capita intake of about 4.6 mg of Ascorbic acid per day which is about 46% of the recommended intake to prevent development of deficiency symptoms, and 23% of the required intake for optimum wound healing. At the same level of consumption, condensed camel milk would provide about 2.2 mg of Ascorbic acid per adult equivalent in the household per day. This represents only 22% of the amount required to prevent development of deficiency symptoms. This intake would be expected to be lower especially if the milk is heated further during making of tea.

6.2.4 Total Niacin:

Total niacin was found to be at the level of 0.6 mg/100 ml in fresh camel milk and 15.2 mcg/g in the condensed camel milk. Sawaya et al., (1984) found the level of the vitamin in fresh camel milk to be 0.46 mg/100 ml.

Niacin is a heat stable vitamin. It is also stable to light, oxygen and alkali (Bender, 1978). During the process of condensation, there was a mean loss of only 5%. The levels of the vitamin also did not change during storage. There were also no significant differences in the levels of niacin at different storage temperatures ($P<0.05$) both after 4 weeks and 8 weeks storage.

The role played by milk in providing niacin in the diets of pastoralists is crucial because the other principal item in their diets is maize, which contains niacin in an unavailable form although it also contains tryptophan which can be converted to niacin when necessary. Milk is a poor source of tryptophan. (Bender, 1992). By consuming an average of 0.48 litres of milk, each adult equivalent has access to approximately 2.9 mg of niacin, which is about 21% of the recommended daily intake (Bender, 1992). Those who can preserve camel milk by condensation would have access to a per capita availability of approximately 0.6 mg of niacin per day during the dry season. Deficiency of niacin is associated more with communities whose diets include substantial amounts of highly extracted maize meal, than with those who normally pound maize in the villages (Passmore and Eastwood, 1986). Deficiency symptoms of niacin, are therefore likely to develop within the community since, milk as the main source of niacin is still inadequate, and the little grain available either from buying or as food aid is usually highly extracted.

6.2.5 Lactose:

Lactose, the milk sugar is a reducing sugar and could therefore get involved in condensation reactions with amino groups and their derivatives (Maillard reactions) during heating thereby promoting discoloration of the product. The main contribution of lactose to the diet is as a source of energy, alongside other forms of carbohydrates.

The level of lactose in fresh camel milk was found to be about 2.4%. There was a loss of 53.1% of lactose during condensation which could be attributed to Maillard reactions and possible hydrolysis to glucose and galactose.

The levels of lactose during storage remained almost unchanged up to the 4th week and did not vary with storage temperature. The levels of lactose, however, fell significantly ($p<0.05$) between the 4th and the 8th weeks of storage. However, this was not accompanied by a change in energy content of the condensed milk, suggesting that what occurred was probably hydrolysis of lactose to glucose and galactose.

6.2.6 Free Fat:

The free fat content of fresh camel milk was found to be 5.7% (Table 5.6). This is comparable to the level of 5.5% reported by Knoess (1984). Other investigators have also reported values of 3.2% (Abdel-Rahim, 1987) and 3.9% (Yagil and Etzion, 1980).

The loss in free fat content during condensation was about 6.7%. This was most probably through oxidation and condensation processes which are both accelerated by heating and exposure to oxygen and sunlight during processing. Oxidative breakdown could also result in loss of unsaturated fats with the eventual loss of essential fatty acids (Bender, 1978).

Reports indicate no significant loss of nutritional value in normal heat processing of dairy products (Bender, 1978). The main contribution of fat to nutrition is the provision of energy. Condensation therefore does not seem to lead to a significant nutritional loss.

6.2.7 Crude Protein

Fresh camel milk was found to contain approximately 3% protein which was comparable to levels of 4%, 2.7% and 3.1% reported by Abdel-Rahim (1987), Abu-Lehia (1987), and Farah and Reugg (1989) respectively.

According to Bender (1978), condensation by evaporation has been reported to lead to a loss of up to 70% of the protein, most probably through Maillard reactions. This is similar to the extent of loss of protein during condensation of camel milk, obtained in this case. The loss of protein which is observed in the process of condensing milk in the presence of reducing sugars points to the following possibilities:

(a) Lysine reacts with reducing sugars, mainly glucose and lactose, forming various compounds such as 1-deoxy-2-ketose that are not hydrolysed by digestive enzymes. The implication of such, is that since lysine is the most limiting amino acid, feeding of the condensed milk to say, growing children may lead to protein deficiency disease, even though the total protein consumed may seem to be adequate.

(b) The severe heating during condensation reduces the availability of other amino-acids such as cystine; reactions can take place between proteins themselves, between the free amino groups of lysine and arginine as well as free acid groups of aspartic and glutamic acids (Bender, 1978). The effect of these reactions would be to reduce bio-availability of amino acids.

(c) Suggestions have been made that the products of Maillard reactions are toxic, but the situation is not yet clear (Adrian and Fragne, 1973). Reactions also occur within proteins themselves, or even with fat oxidation products (Mauron, 1976).

The effects of condensation include making lysine unavailable, such that although the total protein may still appear adequate, bio-availability of lysine might be reduced significantly. Unfortunately loss in biological activity cannot be determined by the conventional methods for total protein determination. Specific protein quality studies would have to be undertaken such as the determination of the amino acid profile.

The contribution of fresh camel milk to the protein requirement of the households is crucial, because many of the households do not have access to other sources of animal protein such as meat.

During periods of good pasture, each adult equivalent consumes about 0.48 litres of milk (of all types) including 0.16 litres of camel milk; this contributes about 9.6% of the recommended protein intake (about 50g per day). In total however about 28.8% of the protein requirement of the community comes from milk. This, in addition to the amount supplied by cereals, which is 50.3g indicates a surplus supply of protein. This finding concurs with reports by Njiru and Field, (1984).

During the dry period however, when there is less milk available from the animals, households get most of their requirements of protein from cereals. The potential of the condensed milk in supplementing this source can only be accurately established by conducting digestibility trials.

6.2.8 Total Ash

Ash represents the mineral content of food. The mineral content of fresh camel milk was found to be comparable to that of the milk of other species of livestock (Kon, 1972). Values similar to those reported by Abu-Lehia (1987), Farah and Reugg (1989), and Sawaya et al. (1984) were obtained in this study. Although the levels of particular minerals in the camel milk were not determined in this study, studies have shown that the ratios of the minerals in camel milk are similar to those in milks of other species of livestock, although with slight variations.

There was an appreciable increase in the ash content of the milk after condensation. This could be attributed to the concentration effect of evaporation. It is also possible that some minerals were added through the sugar, which was not refined. No degradation of mineral elements was expected from the concentration process.

6.2.9 Yeasts and Moulds:

There was no observed growth of mould in any of the samples within the first 8 weeks of storage. However, in the 9th week of storage mould was noticed in a total of 5 out of 12 stored samples. Another 7 samples had mould growth by the 10th week of storage. Growth of moulds was noticed earlier than that of yeasts. Growth of these organisms, however, started only after the samples had been opened and analyses samples scooped. No yeasts or mould growth was in samples which were not scooped from until the end of the storage period. The growth of moulds was thus most probably due to contamination during scooping of the samples for analyses.

The implication of these findings is that even if households were to adopt condensation of camel milk, the period over which they could continue using the product once the cans are opened would depend on the levels of hygiene when scooping out the product from whichever containers it might be stored in. Since in the study population hygiene might be difficult to control, it would be more advisable to store the product in containers that are not too large, and which would allow for use of the product quickly once opened. Otherwise without opening the containers, it would be possible to store condensed sweetened camel milk in aluminium cans that are properly sealed for up to 16 weeks.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

There are no cultural barriers to either rearing of camels or drinking of their milk, both in fresh and condensed form. The strong traditional set-up of the households favours fair intrahousehold distribution of milk, such that during periods of shortage, priority is given to young children. Social accessibility to both fresh and condensed camel milk by members of different households is further enhanced by the fact that many respondents in this survey reported that camel milk is preferred to other types of milk for making tea during social gatherings.

Condensed camel milk has good potential of supplementing energy intake among those households producing and condensing camel milk. However, those households that would have to depend on purchasing the condensed milk would be better advised to purchase energy from cereals, particularly maize which is popular among the area residents. Moreover, a unit of energy from condensed camel milk currently costs about six times more than from maize. Since money is usually a big constraint during the dry period, financial accessibility of the households that do not produce and condense milk is limited.

There are many households that still do not own camels, implying that food security out of own production of condensed camel milk is limited. Food security would also improve if more people adopted rearing of camels because milk producers would sell some of the milk at the shopping centres and purchase grain, which forms a cheaper and popular staple within the study population. By preserving some of the camel milk, producers would also contribute greatly to reducing competition for the little cereal grain available in the markets, since condensed camel milk would boost their energy intake.

Fresh and condensed camel milk have alot of potential as sources of vitamins A and C in the arid and semi-arid divisions of Baragoi and Nyiro, particularly because there is no regular supply of fruits and vegetables in those areas. Although losses of these vitamins occur during evaporative condensation, appreciable amounts of the vitamins are still present in the condensed milk. The breakdown of the vitamins during storage is facilitated by the entry of air when the containers are opened during scooping. Storage temperature of condensed camel milk does not seem to play a significant role in the breakdown of nutrients during storage.

Opening of containers of condensed camel milk during storage exposes the milk to moisture, which facilitates growth of moulds. The tools used for scooping the milk from the tins are also a likely source of contamination. Hygiene during handling of the milk is therefore very crucial.

7.2 RECOMMENDATIONS

1. Education extension programmes, particularly those that are aimed at popularizing the camel as a milk producer in Greater Baragoi should be extended to cover those who are not members of camel improvement groups, so that more people may adopt camel rearing, with a view to making them able to produce and undertake condensation of camel milk in their own homes.

2. Inorder to establish the contribution of sweetened condensed camel milk to protein intake within the community, it is necessary to do further research to establish the bio-availability of different amino acids contained in the milk, owing to the chemical and biochemical reactions that take place during the process of evaporative condensation.

3. Modifications and improvements with a view to standardizing the procedure currently being undertaken in making the sweetened condensed camel milk need to be developed, so as to minimize nutrient losses.

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APPENDICES

APPENDIX 1 : QUESTIONNAIRE USED FOR COMMUNITY SURVEY.

ACCESSIBILITY OF CONDENSED CAMEL MILK IN GREATER BARAGOI, SAMBURU DISTRICT

Date of interview____________ Name of Interviewer______ Name of household head_______________ Name of respondent________________

Ethnicity____________ Relationship to household head____________________________

SECTION A: MILK PRODUCTION DATA

1.Do you own any livestock? Y/N

(Circle the correct response) If No, move to 5.

2.How many of each kind do you own?

Type of livestock	Number
Cattle	_______
Sheep	________
Goats	________
Camels	_______

3.How many of your animals are lactating right now? (Indicate number. If none, move to 5)

Cattle -------

Goats ________

Sheep ________

Camels ________

4. About how much milk are you getting from the animals per day? (Use even local measures to estimate)

Cattle _____litres

Goats _____litres

Sheep _____litres

Camels _____litres

5. How much milk do you consume (for the whole household) each day? _________

6. Is any of the milk produced by your camels left over? Y/N (If No, proceed to 8).

6b. How much camel milk is left over when there is plenty of pasture? ------------- lts.

7. What do you do with the milk which is left over?

i) Give it to neighbours.

ii) Sell it out.

iii) Preserve it for future use.

iv) Pour it out.

v) Other_____________________________ (Specify).

8. For how long does your camel(s) produce milk from when it gives birth?_______________ ______________

9. How much milk does the camel produce during the wet period? _______________lts.

10) Have you ever preserved any left over camel milk? Y/N (IF NO, PROCEED TO

11) What method of preservation did you use?

1. Fermentation

2. Condensation

3. Pasteurization

4. Local method

5. Other________________________ (Specify)

12). Why did you choose this particular method?

1. Traditional beliefs

2. Only method known

3. Product obtained is liked

4. Other________________________ (Specify)

13). Do you sell any of the left over milk ? (y/n) If so about how much do you sell per day? ________________________

14). Have you ever tasted condensed camel milk? Y/N (If No, proceed to 18)

15). What is your opinion on the milk? (Circle correct response)

1. Very delicious

2. Delicious

3. Acceptable

4. Not acceptable

16). If not acceptable, what didn't you like about the milk? (Circle correct response)

1. Colour

2. Taste

3. Smell

4. Texture

5. Consistency

17).What was the source of the condensed camel milk which you tasted? (Circle the correct response)

1. Bought

2. Given by a neighbour/friend

3. Made my own

4. Other__________________ (Specify)

(If 3 proceed to 19).

18).Do you know how to make condensed milk? Y/N (If No, proceed to 21)

19).Have you ever fed your family on condensed camel milk? Y/N

20).If so, how much did they consume per day?______litres

21).Have you ever seen condensed camel milk being made? Y/N

22) Do you know of a place where condensed camel milk is sold? Y/N. (If Yes, proceed to 23)

23).How far is it from here? (Circle correct response)

1. < 4 Km

2. 4 -6 Km

3. 6 - 10 Km

4. > 10 Km

24) If condensed camel milk was made available in the shops, would you be willing to

buy? Y/N.

25).Do you ever move your animals to other grazing areas during the dry period? Y/N

26).How much luggage can the donkey carry?————kg.

27).Do you ever exchange camel milk with any other kind of food? Y/N. (If no proceed to 30).

28). If yes list the foods commonly exchanged and their amounts per cup/glass of milk.

food item	amount exchanged measure

29).Do you exchange camel milk (fresh or condensed) with any non-food item? Y/N

If so name the items and list what they are used for :

ITEM	USE

SECTION B: SOCIO-ECONOMIC DATA

30). How many people have been staying with you in your manyatta for the past 3 months?________________

30b). How many of them are:

Children -----------

Adults ____________

31). Are you currently employed? Y/N (If No, move to 36).

32) If yes, what kind of employment?

1. wage employment
2. self employment

33). Approximately how much did you earn last month? (Circle the correct response)

1. < Kshs.1500
2. Kshs.1500 - 2000
3. Kshs.2000 - 4000
4. > Kshs.4000

34). Did you buy any food last month? Y/N.

If yes, name the foods bought and how much of each type:

FOOD TYPE	AMOUNT PURCHASED

35).Did you receive any food aid last month? Y/N.

If so, how much of each type was received?

TYPE OF FOOD	AMOUNT RECEIVED
cereals	______________________________
pulses	______________________________
oils	______________________________
milk	______________________________
other(specify)	______________________________

36).About how much do you spend on milk per day? ________

37).About how much do you pay for one litre of:

cow milk ______________________________

goat milk ______________________________

camel milk ______________________________

other type(specify) ______________________________

38).Do you sell any animals when the dry season sets in? Y/N/ (If No, move to 42)

39).If so, how many do you usually sell at this time?

cattle________ goats__________

sheep_________ camels_________

donkeys________

40).What are your reasons for not selling the animals even when they are threatened by draught?

(List the reasons)

1) prestige

2) fear of being unable to restock

3) value attached to livestock ownership.

4) other (specify)______________________

41) Do you grow any crops? Y/N (If No, proceed to 45.

42).If so, how much did you harvest of the crops last season?

Crop	Yield
____________	____________
____________	____________
____________	____________

43).Are there any traditional/cultural beliefs that prohibit you from keeping camels? Y/N

If so, please list the beliefs below.

____

44).Are there any cultural beliefs that prohibit you from drinking camel milk? Y/N

If so, please list those beliefs below:-

____

45).Are there cultural beliefs that prohibit the condensation of camel milk? Y/N

46).Are there any members of the household who are prohibited from taking camel milk? Y/N

If so, which members of the household are prohibited and why?

Group | Reason

____________ ____________

____________ ____________

47). Are there any special social functions when condensed camel milk is preferred to other types of milk? Y/N

If so, why?____

____