Subclinical mastitis affecting hygienic quality of marketed camel milk from North-Eastern Province, Kenya

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ABSTRACT

In North-Eastern Province, camel is the dominant livestock; it provides subsistence to many people especially during the frequent droughts when other animals either die or are unthrifty. This is because camel is highly suited for hot environments. In this region, camels number approximately 3 million and are the main producers of milk for the residents, who are mainly of Somali origin, and are pastoralists. Currently, the milk is also sold in Nairobi and other far places; and there is a fast-growing demand for it. This has necessitated examination of the milk quality, in response to food-safety awareness, especially noting that some of the bacteria causing subclinical mastitis can cause disease in humans. This study was carried out to establish the hygienic quality of camel milk from this area, zeroing down to 2 districts, Garissa and Wajir. Three hundred and eighty four bulk camel milk samples were collected in volumes of 200 to 300 ml. They were transported to the laboratory in cold/ice boxes and bacterial isolation and characterization done not later than 24 h after arrival at the laboratory. Before culturing, the milk samples were screened using California Mastitis Test (CMT); samples testing positive (an indication of subclinical mastitis) were then subjected to bacteriological investigation, using standard methods. Results of this study have shown that subclinical mastitis is prevalent in dromedary camels of Garissa and Wajir districts of North-Eastern province of Kenya, and that Gram-positive cocci (Staphylococcus and Streptococcus) are the dominant mastitis pathogens isolated. Other isolated bacteria included Klebsiella/Enterobacter, Escherichia coli and Bacillus. The positive correlation of CMT with the presence of mastitis pathogens in camel milk showed that CMT is a useful screening test in the detection of subclinical mastitis in camels; it is thus a useful tool for farmers, aiding them in picking the affected animals, segregating and treating them. The results also contribute towards coming up with respective control measures so as to keep camel milk fresh for longer periods and also make it safe for human consumption.

Keywords: Subclinical mastitis, camel milk, North Eastern Kenya.

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INTRODUCTION

The camel population in Kenya is approximately 3 million of which more than half are reared in North Eastern Province (National census, 2009). The camels are reared together with sheep, goats and cattle but the camels are the key milk providers especially during the dry seasons when other animals die or are unthrifty (Guliye, 2006). The milk is used by pastoralists to provide high quality nutrition especially to children as well as serving as a source of income for many livelihoods. Milk is a good medium for several bacteria to thrive in. The growth of bacteria in milk depends mainly on temperature and presence of other bacteria (Heeschen, 1994). As camel milk is usually consumed in its raw state, either fresh or in varying degrees of sourness by the pastoralists, the presence of pathogenic bacteria may be of public health importance besides its influence on animal health as reported by Saad and Thabet (1993) as well as Younan (2004). Generally, bacteria in milk can occur through
colonisation of the teat canal or an infected udder (clinical or subclinical mastitis), or as contaminants (Younan, 2004).

Milk can get contaminated at different points; first during milking (the source being udder infection, milking equipment, or milking person); others are: during transportation and/or storage of the milk. The main reasons for spoilage of milk are bacteria; most of which are saprophytic, but some are pathogenic and zoonotic (Heeschhen, 1994; Semereab and Molla, 2001).

A high percentage of subclinical mastitis in camels is reported by several authors (Barbour et al., 1985; Abdurahman et al., 1995; Obeid et al., 1996; Almaw and Molla, 2000). The pathogenic bacteria reported by different scientific groups are similar to bacteria reported in mastitis of cows or other animals kept in traditional nomadic environment or camel farms (Barbour et al., 1985; Almaw and Molla, 2000). The total bacterial count (TBC) of camel milk is reported with values that vary between $10^2$ and $10^4$ cfu/ml by Semereab and Molla, 2001; Wernery et al., 2002; Younan, 2004. These differences underline the fact that TBC depends on several parameters: bacteria originally present in the camel milk, contamination of the camel udder, contamination of the person doing the milking, contaminated containers etc. The relation of the different sources of contamination varies according to the keeping and milking conditions of the camels. Under pastoral production conditions, environmental contamination is likely to play a major role in the hygiene of raw camel milk than initial bacterial contamination of the camel milk (Younan, 2004). If the TBC is low, raw milk was observed not to turn sour for 4 days, when it was kept in a clean container and refrigerated (Younan, 2004).

Poor management and unhygienic milking practices prevalent in the traditional husbandry systems, which include tying of the teats with soft barks to prevent the calf from suckling, tick infestations and catarization of the udder and skin, are few of the factors responsible for contamination of milk (Abdurahman, 1995; Almaw and Molla, 2000; Obeid et al., 1996; Woubit et al., 2001). This study was therefore aimed at determining the bacteriological quality of raw camel milk.

MATERIALS AND METHODS

Study area

The study was carried out in Garissa and Wajir districts of North-Eastern province from January 2008 to December 2008. These are two of the four districts making up the expansive North Eastern province of Kenya. They lie in the Arid and Semi-Arid Lands (ASAL) of the country. The rainfall pattern is erratic and unreliable. It is always less than 600 mm annually. Temperature ranges between 22 and 42°C. The districts are flat, covered by trees and shrubs with grass undergrowth. Water sources are rivers (permanent and seasonal), pans, boreholes, dams and shallow wells. The mainstream activity of the two districts is livestock keeping. The livestock are kept under pastoralist system. They include cattle, sheep, goats, camels, donkeys and poultry. Nomadic pastoralist communities living in ASAL regions largely depend on milk produced by camels which contribute 80% of the household needs (Schwartz and Dioli, 1992; Guliye, 2006). Surface water is a serious problem in this area. Animal husbandry is characterized by extensive pastoral production system and seasonal mobility. Camel and cattle herd splitting into mobile "forra" and home-based "herd" is practiced as strategy to mitigate forage and water shortage. Camel herd movement may be moving the whole herd to water point and to relatively high altitude where green forage is available.

Study design

The study was cross-sectional. Marketed milk was used and subclinical mastitis was detected using California mastitis testing and isolation and characterization of bacteria. CMT was done first, samples testing positive were then subjected to bacteriological study (Gram staining, culture and identification).

Sample collection

Samples of raw milk, produced by locally-kept camels, were collected from various market points in the two districts. Volumes of 200 to 300 ml of bulk camel milk (from producers or hawkers) were collected into labeled sterile bottles and kept in an ice box. They were then transported to laboratory for bacteriological isolation and identification; this was done either immediately or after keeping them for not more than 24 h in a refrigerator. The number of samples processed was 384 (230 km from Garissa and 154 km from Wajir).

Sample size determination for the milk samples

The sample size (n) was determined by estimation of the proportion as anticipated prevalence of mastitis in camels. The prevalence of mastitis in camels in Kenya is estimated at 25% as reported by Younan et al. (2001).

\[ n = \frac{Zα/2pq/L^2}{0.75/0.05} = 300 \]

(camel milk samples)

Where:

- \( n \) = the required sample size
- \( Zα \) = 1.96 = the normal deviate at 5% level of significance
- \( p \) = the estimated prevalence (in percentage)
- \( q = 1 − p \)

California mastitis test (CMT)

California mastitis test was done using a modification of the procedure described by Schalm et al. (1971). A CMT kit, carried out following standard methods (Quinn et al., 1994; Schalm et al., 1971), was used to screen the 384 milk samples for subclinical mastitis. Interpretation of the test was based on the amount of gel formation in the sample (Table 1).

Demonstration of bacterial presence in the milk samples

This was done through direct observation (Gram staining) and later through culture and characterization.

Gram stain procedure was performed according to the method described by Forbes et al. (2002) and Bebora (2007), while bacterial culture and characterization were carried out following
Table 1. CMT reaction and equivalent milk somatic cell counts (SCC) in cattle applied to camel milk.

<table>
<thead>
<tr>
<th>Test results</th>
<th>Reaction observed</th>
<th>Equivalent milk SCC (cells/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>No gel formation</td>
<td>0 – 200,000</td>
</tr>
<tr>
<td>Trace</td>
<td>A slight slime formation</td>
<td>150,000 - 500,000</td>
</tr>
<tr>
<td>1+</td>
<td>Distinct slime formation immediately</td>
<td>400,000 - 1,500,000</td>
</tr>
<tr>
<td>2+</td>
<td>Formed slime settles at the bottom and side</td>
<td>800,000 - 5,000,000</td>
</tr>
<tr>
<td>3+</td>
<td>Formed slime is convex and domed up</td>
<td>&gt;5,000,000</td>
</tr>
</tbody>
</table>

Source: Radostits et al. (2005)

Table 2. Frequency distribution for California Mastitis Test for Garissa and Wajir milk samples, separately and collectively.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Garissa n = 230</th>
<th>Wajir n = 154</th>
<th>Garissa and Wajir combined n = 384</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall positive</td>
<td>139 (60%)</td>
<td>96 (6%)</td>
<td>235 (61.2%)</td>
</tr>
<tr>
<td>2+</td>
<td>4 (3%)</td>
<td>10 (6%)</td>
<td>14 (3.7%)</td>
</tr>
<tr>
<td>1+</td>
<td>58 (25%)</td>
<td>40 (26%)</td>
<td>98 (25.5%)</td>
</tr>
<tr>
<td>Trace score</td>
<td>77 (33%)</td>
<td>46 (30%)</td>
<td>123 (32.0%)</td>
</tr>
</tbody>
</table>

standard methods as described by Quinn et al. (1994) and Sears et al. (1993). Culture was done on 7% sheep Blood Agar and MacConkey agar plates, incubated aerobically at 37°C for 24 to 48 h. Presumptive identification of bacterial isolates on primary culture were made based on colony morphology and hemolytic characteristics on blood agar. These were then subcultured to produce respective pure cultures, which were Gram stained. Further characterization of members of the family Enterobacteriaceae comprised carrying out of several tests, including: Indole test, methyl-red test, Voges Proskauer test, citrate utilization test, urease test, catalase test, oxidase test, reaction on triple sugar iron agar and on sulphur indole motility medium (Quinn et al., 1994; Sears et al., 1993; Forbes et al., 2002). *Staphylococcus* and *Micrococcus* species were identified based on their growth characteristics on mannitol salt agar (MSA), coagulase production, catalase, and oxidase tests. *Streptococcus* species were evaluated according to CAMP reaction, growth characteristics on 7% sheep blood agar, catalase production and sugar fermentation tests (Quinn et al., 1994; Sears et al., 1993; Forbes et al., 2002).

Primary bacterial isolation was done in the field laboratory (Garissa District Veterinary Investigation Laboratory (VIL). Bacterial colonies from the two primary isolations (7% sheep blood agar and MacConkey agar) were inoculated into nutrient agar slants (transport media), incubated at 37°C for 12 h, and then stored at 4°C in Garissa VIL. These colonies were later transported in a cool box to the University of Nairobi, bacteriology laboratory for secondary bacterial culture and further biochemical testing/characterization, using the same type of media.

Data analysis

Data collected was entered into Ms-Excel as data package for processing and was analyzed with Instat for windows to obtain frequency distribution for California Mastitis Test (CMT) and isolation of various bacterial microorganisms including *Staphylococcus* species, *Micrococcus* species, *Streptococcus* species, *Bacillus* species, *Escherichia coli*, *Klebsiella* species and *Enterobacter* species.

RESULTS

Results of California mastitis test (CMT)

Frequency distributions for CMT positive reactions for Garissa and Wajir districts, separately and collectively, are given in Table 2, while Figure 1 gives comparison of frequencies, in percentage, of CMT for the 2 areas, separately and collectively.
Table 3. Bacteria isolated from camel milk samples from Garissa and Wajir districts.

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Garissa n = 230</th>
<th>Wajir n = 154</th>
<th>Garissa and Wajir combined n = 384</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>Total isolated</td>
<td>202</td>
<td>87.8</td>
</tr>
<tr>
<td></td>
<td>Coagulase positive</td>
<td>69</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>Coagulase negative</td>
<td>133</td>
<td>57.6</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>Total isolated</td>
<td>195</td>
<td>84.8</td>
</tr>
<tr>
<td></td>
<td>CAMP positive</td>
<td>72</td>
<td>31.3</td>
</tr>
<tr>
<td></td>
<td>CAMP negative</td>
<td>123</td>
<td>53.5</td>
</tr>
<tr>
<td>Bacillus species</td>
<td>116</td>
<td>50.4</td>
<td>60</td>
</tr>
<tr>
<td>E. coli</td>
<td>168</td>
<td>73.0</td>
<td>62</td>
</tr>
<tr>
<td>Klebsiella/Enterobacter</td>
<td>221</td>
<td>96.1</td>
<td>148</td>
</tr>
</tbody>
</table>

Figure 2. Percentage comparison of CMT score.

Of the 384 camel samples (230 from Garissa and 154 from Wajir) investigated for subclinical mastitis, 235 (61.2%) gave positive reactions. The equivalent somatic cell counts (SCC/ml) of the positive samples (as extrapolated from CMT observations) ranged from $1.5 \times 10^5$ to $5 \times 10^6$ leucocytes per milliliter of milk. Majority of the CMT reactions were traces (representing cell counts of between 800,000 and 5,000,000 cells/ml), followed by 1+ (representing cell counts of 150,000 to 500,000 cells/ml); few gave reactions of 2+ (representing cell counts of 400,000 to 1,500,000 cells/ml). For Garissa and Wajir, separately, 139/230 and 96/154 gave positive reactions, respectively. For both, the majority of the reactions were traces, followed by 1+ scores. Those with 2+ scores were fewer. It was noted, however, that Wajir samples gave a higher percentage of 2+ scores and lower percentage of trace scores than Garissa.

Bacteriological results

Gram staining revealed the presence of both Gram positive and Gram negative bacterial cells in the milk samples tested. This result was used as an indicator for the primary isolation of the bacteria in media. The various bacteria (and their respective prevalences) isolated from the camel milk samples from Garissa and Wajir, respectively, and as combined data, are given in Table 3, while respective percentages are given in Figure 2. Breakdowns of isolated Staphylococcus and Streptococcus, with respect to coagulase production and CAMP reaction, respectively, are given in Figures 3 and 4.
Overall all the milk samples yielded mixed types of bacteria on culture. The most isolated bacterium was *Klebsiella/Enterobacter* (at 96%), followed closely by *Staphylococcus* (90%) and *Streptococcus* (85%). The others were *E. coli* (60%), and *Bacillus* (46%). Coagulase-positive *Staphylococcus* was isolated at 24% and CAMP-positive *Streptococcus* at 27%. When considered separately, Garissa yielded more of *Bacillus* (Garissa 50% and Wajir 39%) and *E. coli* organisms (Garissa 73% and Wajir 40%) than Wajir, while Wajir yielded more *Staphylococcus* than Garissa (94% in Wajir and 88% in Garissa); *Streptococcus* (85%) and *Klebsiella/Enterobacter* (96%) were isolated at more-or-less the same rate in both areas. Garissa yielded more (30%) coagulase positive *Staphylococcus* than Wajir (14.3%), despite more *Staphylococcus* having been isolated from Wajir (93.5%) as compared to Garissa (87.8%). Garissa also yielded more (31.3%) CAMP positive *Streptococcus* than Wajir (19.5%); *Streptococcus* was isolated at same prevalence (85%) for the two areas (Figure 5). This high bacterial carriage indicated presence of subclinical mastitis, leading to sale of poor-quality milk, the source of contamination being both inherent and environmental. If not processed properly, the milk could be a source of disease in humans.

**Discussion**

The prevalence of sub-clinical mastitis in the two districts...
according to CMT results was 61.2%, with a CMT trace score accounting for 32.0%, 1+ score accounting for 25.5% and 2+ score accounting for 3.7%. These findings are in accordance with earlier published report from dromedary she-camels in Jordan (Hawai and Hassawi, 2008), with the most predominant bacterial isolates being Gram-positive cocci of genera: *Staphylococcus*, *Streptococcus* and *Micrococcus*. Since the milk samples in this study were collected from bulked/pooled milk from different camels and producers, this was taken as an explanation for the recorded high prevalence of these two major mastitis-causing pathogens, which normally originate from the udder. The prevalences were higher than those recorded by other researchers (Abdurahman et al., 1995; Al-ani and Al-Shareefi, 1997; Barbour et al., 1985; Obied et al., 1996; Quadil and Quadar, 1984) who based their figures on quarter-milk samples. However the high prevalence of coliforms (*Escherichia, Klebsiella/Enterobacter*) and *Bacillus* was attributed to contamination of milk containers from the environment due to the poor hygiene in handling milk along the collection and marketing chain, including the various containers used. The influence of pooling of different camel milk batches along the collection and marketing chain was illustrated by the increase in prevalence of *Streptococcus agalactiae* (26.56%), an observation supported by Younan et al. (2002). The positive correlation of CMT with the bacteriological findings indicated that camel milk, like that of cows (Schalm et al., 1971), goats and sheep (Coetzer et al., 1994), has phagocytic cells which normally constitute one of the essential defenses against microbial infections. It also indicated that these phagocytic cells constitute one of the essential defenses against microbial infection of the mammary glands. An increase in the number of somatic cells, particularly granulocytes (as extrapolated through CMT), in camel milk is a good indication of inflammation. As in the cow, the intensity of the cellular reaction correlates with the degree of irritation of the mammary gland. This confirms that CMT can be used as a screening test to detect subclinical mastitis in camels; an observation that was also made by other researchers (Barbour et al., 1985; Saleh and Fave, 2011). The estimates of the somatic cell counts of the milk samples, as extrapolated through CMT, (of between 1.5 × 10^5 and 5 × 10^6 leukocytes/ml of milk), found in this study, are in agreement with those of Kospakov (1976), cited by Abdurahman et al. (1995), who reported a mean score of 1.3 × 10^6 leukocytes/ml from milk samples in Bactrian camels.

The relative number of the various pathogens isolated in this study, especially that of *Staphylococcus aureus* and *Streptococcus species*, is very similar to that reported by Woubit et al. (2001) and Abdurahman (2006). This study has thus confirmed what other researchers (Barbour et al., 1985; Woubit et al., 2001) have found that *S. aureus* and *Streptococcus* spp. are major causative agents of mastitis in camels. However, camels have not been the subject of experimental mastitis studies and the epidemiology and pathogenicity of mastitis-causing organisms remain unclear. Camels affected by mastitis are reported to have considerably shorter lactation periods (Barbour et al., 1985). The disease is not usually treated in traditionally managed camels and will often take a natural course to chronicity resulting in permanent loss of milk production (Abdurahman et al., 1991; Obied et al., 1996). The isolation of *Streptococcus agalactiae* and other major mastitis pathogens could thus be attributed to the lack of supply and infrequent use of antimicrobials, and inaccessibility of veterinary services for the camel owners, as compared to the dairy cow owners, in urban and peri-urban areas (Woubit et al., 2001).
Considering the isolated environmental coliforms, Klebsiella/Enterobacter species were isolated at a much higher rate (96%) than E. coli (60%). It was demonstrated through another study that the traditional husbandry systems carried out by these people included poor management and unhygienic milking practices like dry milking and tying of the teats with soft barks to prevent the calf from suckling, and cauterization of the udder skin. The animals were also infested by ticks on the udders. These predispose the udders to bacterial infections, which may persist as chronic infections. These factors have also been documented by other workers (Abdurahman et al., 1995; Obeid et al., 1996; Almaw and Molla, 2000; Woubet et al., 2001). The chronic infections could result in induration and atrophy of injured quarters and loss of milk production (Obeid et al., 1996; Abdurahman et al., 1991).

Conclusions

Results of this study have shown that subclinical mastitis is prevalent in dromedary camels of Garissa and Wajir districts of Northeastern province of Kenya, and that Gram-positive cocci are the dominant mastitis pathogens isolated. The positive correlation of CMT with the presence of mastitis pathogens in camel milk showed that CMT is a useful screening test in the detection of subclinical mastitis in camels; it is thus a useful tool for farmers, aiding them in picking the affected animals, segregating and treating them. The results are significant as they contribute towards coming up with respective control measures so as to keep camel milk fresh for longer periods and also to make it safe for human consumption. Increased awareness on hygienic milking practices and use of simple tests like CMT as well as use of aluminum cans (which are easy to clean) can greatly contribute to improved quality of milk for sale and consumption. The use of these technologies and their impact on milk hygiene need to be evaluated in the future.

ACKNOWLEDGEMENT

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APPENDIX

Questionnaire format for camel milk producers (pastoralists and farmers) in Garissa and Wajir Districts

Camel milk chain enhancement in Garissa and Wajir District questionnaire for camel milk producers (farmers and pastoralists) - 2008/2009

[I]: Introduction

Good morning/afternoon/evening. My name is DR. WANJOHI. I am an interviewer from the University of Nairobi which is a teaching and a research institution. Today, we are conducting a study to identify the constraints in the camel milk chain with a view to designing appropriate solutions and we would be very grateful to get your input. We uphold the secrecy and confidentiality of any information provided. I wish to state that any information provided will be used for the purpose of the study only.

[II]: General

Date: Day / Month / Year. __________ / __________ / __________

1. Name of the respondent.__________________________________________________________________________

2. District._________________ Division._______________ Location____________________
Sub-location_________________ Village________________________

3. Name of the group __________________________. Membership _____________________

4. GIS (Geographical Information System) location.__________________________________________

5. Number of people in the household.__________________________________________________________

[III]: Livestock keeping

1. What livestock do you keep and how many of each? (i) Cattle_________ (ii) Camels_________ (iii) Sheep_________ (iv) Goats_________ (v) Others (Specify) _______________

2. Why do you keep Camels? (i) Consumption_________ (ii) For sale__________ (iii) For traditional ceremonies_________ (iv) For milk production_________ (v) Others (specify) _______________

3. Where do you graze and water your Camels? (i) Graze__________ (ii) Water________________________

4. How often do you water your camels? (i) Daily _____ (ii) Every 3 to 5 days___________ (iii) Once a week________ (iv) Monthly_________ (v) Others (specify) _______________

5. Do you give extra feed to your camels apart from grazing? _______________________

6. If yes why do you give these extra additives? _____________________________________________. Where do you obtain them from?

7. What are the age groups of the camels that you have and what are the numbers? (i) Adult-females ____ (ii) Adult-males ______ (iii) Wearners and Growers ______ (iv) Calves _______

8. How many adult females are milking? ___________

9. How many times do you milk your camels in a day and how much milk is produced per milking? _______ (i) Morning_________________ (ii) Evening_________________________

10. What is the average amount of milk produced by the camel per day? (i) During dry season____________________ (ii) Wet season_____________

11. Who does the milking? ____________________________________________

12. What milking procedure do you use? ____________________________________________

13. What problems are encountered during milking? (i) Swollen painful udder and teats _____ (ii) Milk discoloration (bloody /reddish) _________ (iii) Change in milk consistency (watery, clotted, creamy) ________ (iv) Traumatic lesions on the udder and teats ____________

14. For how long do you milk your camels before they deliver again? ______________________

15. What containers do you use for milking, preserving and transportation of the camel milk and what are their costs?

<table>
<thead>
<tr>
<th>Milking</th>
<th>Transportation</th>
<th>Preservation</th>
<th>Cost per container</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic containers</td>
<td>_______</td>
<td>___________</td>
<td>_________</td>
</tr>
</tbody>
</table>
16. Do any of the above containers belong to any group? ___________. If yes what is the name of the group?

17. How often do you wash / clean your milk containers? (i) Immediately after milking ___________ (ii) Just before the next milking ________ (iii) Others (specify) ___________

18. How do you wash your milk containers? (i) Use of detergent ______ and its name ____________ (ii) Use of cold, warm or hot water ____________ (iii) Use of disinfectant and its name ____________

19. What is the purpose of the milk produced by the camels? (i) Sale ____________ (ii) Domestic consumption__________ (iii) Feeding calves ____________ (iv) Others (specify) ____________

20. What quantity of camel milk is sold? (i) Fresh ____________ (ii) Sour ____________

21. Who takes care of the camels by grazing and watering them? ____________ and who makes management decisions? ____________

22. What diseases have you noticed in your herds of camels? (i) Mastitis ____________ (ii) Trypanosomiasis ____________ (iii) Brucellosis/ Abortion ____________ (iv) Diarrhoea ____________ (v) Udder injury (physical) ____________ (vi) Others (specify) ____________

23. How do you have your animals treated when they are sick? (i) Gok Veterinarian ____________ (ii) Private veterinarian ____________ (iii) Traditionally using herbs ____________ (iv) Owner treatment using conventional medicine ____________ (v) Others (specify) ____________

24. What happens to milk from a mastitic camel? (i) Sold ____________ (ii) Pour it ____________ (iii) Given to calves ____________ (iv) Domestic consumption ____________

25. What do you do with milk produced from treated camels? (i) Sold ____________ (ii) pour it ____________ (iii) Given to calves ____________ (iv) Domestic consumption ____________

26. How is the camel milk meant for home use consumed? (i) Consumed raw ____________ (ii) Boiled before consumption ____________ and for how long boiling ____________

27. Why is camel milk consumed raw without pasteurizing first? ____________

28. Do you add any additives to camel milk after milking? ____________ What are the reasons? ____________

29. How do you store your camel milk after milking before disposing? ____________

30. How long does it take to dispose of camel milk for sale after milking? ____________

31. Who are your customers for the camel milk? (i) Neighbours ____________ (ii) Hawkers ____________ (iii) Bulkers /Retailers ____________ (iv) Co-operatives/Processors ____________

32. How much do you sell a litre of camel milk?, (i) During wet season ____________ , (ii) During dry season ____________. Are you comfortable with these prices? ____________

33. How strong is the demand for camel milk during wet and dry seasons? (i) Wet season ____________ (ii) Dry season ____________

34. Do you have any intention of coming together and form a camel-milk marketing society? ____________

35. What else do you think will help you fetch more money from your camel milk? (i) Process own milk ____________ (ii) Improve on milk hygiene ____________ (iii) Others (specify) ____________

36. Would you or any member of your family / group like to be trained in camel-milk and udder hygiene? ____________. For how long would you like to be trained? (i) Three days ____________ (ii) Four days ____________ (iii) Five days ____________ (iv) One week ____________

37. Do you have any credit access to improve on your camel rearing / keeping activities? ____________. If no would you be interested in some? ____________. What would you do with such a credit? ____________

38. What do you do to preserve your camel milk for longer periods of time? (i) Boiling ____________ (ii) Cooling ____________ (iii) Adding Antimicrobials ____________ (iv) Adding Hydrogen peroxide ____________ (v) Others (specify) ____________

39. How would you suggest camel milk be cooled? _____________. Would you be willing to pay for cooling services? ____________