ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 17 No. 1 March 2017 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2017; **17(1):** 11803-11821 **DOI: 10.18697/ajfand.77.16885**

KNOWLEDGE AND PRACTICES OF FOOD HYGIENE AND SAFETY AMONG CAMEL MILK HANDLERS IN THE PASTORAL CAMEL VALUE CHAIN IN KENYA

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ABSTRACT

Camel milk contributes up to 30% of pastoral community annual caloric intake making it one of the main diets for the pastoral community. In addition, camel milk is a major source of income and serves significant cultural functions in pastoral communities. Despite these, camel milk production and marketing is faced with a number of challenges, especially poor handling practices that contribute to high post-harvest losses due to poor quality and safety. Poor handling practices have been reported to be associated with poor knowledge and practices of food hygiene and safety among the pastoral camel milk value chain actors. The study aimed at determining the level of food hygiene and safety knowledge and practices of camel milk value chain actors. A structured questionnaire, focus group discussions and key informant interviews were used to collect data on hygienic milk handling knowledge and practices along the camel milk value chain. Each point along the chain showed a significant difference ($p<0.05$) in knowledge in food safety and hygiene. The study established that herdsmen had significantly ($p<0.05$) lower knowledge than women retailing and collecting/ bulking milk at Isiolo town and its environs with a mean score of 49 ± 9%. The women retailing at Isiolo town scored 62 ± 9% of the food hygiene and safety questions correctly. The women at the collection/bulking centre had the highest knowledge level with a score of 69 ± 10%. The average score along Isiolo camel milk value chain was 60 ± 9%. The respondents showed low knowledge in answering questions regarding spoilage microorganisms and effective cleaning of containers. About 53% of women retailers used rejected/spoiled milk for household consumption. This could result in a high food safety risk. Therefore, training of actors along the camel milk value chain could be the best way to improving their knowledge on food safety and hygiene.

Key words: Knowledge, food safety, food hygiene, milk handlers, container cleaning

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INTRODUCTION

Camel husbandry is mainly practiced in the arid and semi-arid lands (ASALs) by the pastoral communities who keep the one humped camel (*Camelus dromedarius*). There are about 27 million camels worldwide [1]. Camel production in Africa accounts for 82.5% of the total world camel population. Kenya is the third country in Africa in camel production with the camel population at approximately 3 million [1, 2]. The ASALs are characterized by high levels of poverty, poor infrastructure, extreme weather, lack of adequate pasture, and a fragile environment among other challenges. Despite these challenges in the ASALs, the annual camel milk production in Kenya in 2008 was estimated at 338.3 million litres, valued at USD 107.1 million [3] which represented 12% of the national milk production [4]. However, this increased drastically to 937 million litres in 2013 [1]. Camel milk forms one of the basic diets for the pastoral community contributing up to 30% of their annual caloric intake [5]. In addition, camel milk is a major source of income and serves a significant cultural function to the pastoral communities [4, 6, 7, 8, 9].

Despite the major contribution of camel milk to the livelihoods of the pastoral communities, production and marketing systems along the camel milk value chain face numerous challenges. Most of the challenges are related directly to the quality and safety of the milk and consequently lead to enormous losses of the milk along the chain. This has led to camel milk from the pastoral community being rejected by consumers and processors. The main contributory factor to poor quality and safety is poor hygiene during milk harvesting and handling. Poor hygiene is as a result of interaction of several risk factors along the camel milk value chain. These factors include inadequate or unavailable potable water for washing containers, use of plastic containers which are difficult to clean, poor infrastructure and long durations during transportation at high ambient temperatures which promote growth of microorganisms, among other factors [10 - 13]. These factors are likely risks to camel milk contamination, hence leading to quality deterioration and loss. Camel milk contamination occurs at every node of the chain along the milk production chain due to the unhygienic handling practices.

Although several studies have been done to determine the challenges facing camel milk production and reported unhygienic handling in the ASALs, the food safety and hygiene knowledge level and practices of those involved in handling the camel milk has not been studied. The understanding of food safety and hygiene knowledge level and practices of the camel milk producers and handlers will contribute towards designing training programmes that will improve the hygiene and hence the safety and quality of the marketed camel milk. This will in turn reduce wastage and losses, increase income and improve pastoralists' livelihoods. This study was, therefore, developed to determine the food hygiene and safety knowledge level of the camel milk producers and handlers along the pastoral value chain in Isiolo County, Kenya.

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MATERIALS AND METHODS

Study area

The study was conducted in Isiolo County, a typical ASAL area in north-eastern Kenya with both peri-urban and pastoral camel production systems and a thriving camel milk trade, and Nairobi (Eastleigh estate), the terminal market for the Isiolo camel milk value chain. Isiolo County is a semi-arid area that experiences recurring droughts with devastating losses of livestock. Most parts of the county have mean annual temperature of between 24°C and 30°C [14].

The camel milk production in Isiolo County is done by Somali tribesmen who form the majority of the camel owners in peri-urban (80%) and pastoral (90%) systems. The Borana tribesmen, who traditionally kept cattle until recurrent prolonged drought threat spells in ASAL areas, awakened their interest in camel keeping. The Borana tribesmen form 18.3% of peri-urban camel handlers and 10% of the pastoral system [15]. About 87.5% of the produced camel milk is consumed either at the local trading centres or for subsistence at the household level [3]. The Isiolo County has been approximated to have a camel population of 45,000.

Data collection

Data were collected through a cross sectional survey using structured questionnaires, focus group discussions (FGDs), key informant interviews and personal observations. Purposive sampling was used to select the respondents based on their accessibility, location and point along the milk chain. The selected respondents were 75 herdsmen (who take care of the camels and milk the camel), 75 women at the collection/bulking centre in Isiolo town and 85 women retailing camel milk within Isiolo town and its environs. The structured questionnaires aimed at determining food safety, hygiene knowledge and practices of the respondents along the camel milk value chain and was designed based on Sharif *et al.* [16]. All questions about food safety and hygiene knowledge were scored on a five-point scale of 1=strongly disagree, 2=disagree, 3=not sure, 4=agree or 5=strongly agree. The questions about practices were partly scored and some not scored. The direction of the scale was (1 to 5) and reversed to (5 to 1) for some questions to check the validity of the responses. For dichotomous classification the scores less than 4 were categorized as a negative response (answering wrong/incorrect) while the scores 4 and 5 were categorized as a positive response (answering right/correct).

Statistical analysis

Data were analyzed using SPSS Statistics Version 20.0. Qualitative data from FGDs and the key informant interview were transformed and written into descriptive prose. The responses were also reclassified into two categorical responses: correct and incorrect response (scores less than 4 were categorized as a wrong / incorrect response while the scores 4 and 5 were categorized as a right/correct response). The rate of correct responses for each question was then described. The mean score for each question was transformed into a percentage score for presentation and interpretation of the results. One-way ANOVA test was used to compare the mean score at different points along the chain and within each point of the chain using Tukey's tests to identify significant difference at $P<0.05$.

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RESULTS

Knowledge on food hygiene and safety along the camel milk value chain

The average score of camel milk actors'/ handlers' knowledge on food hygiene and safety along the Isiolo camel milk value chain was 60.0 ± 9.4%. The herdsmen had the lowest average knowledge score of 49.4 ± 9%. The retailing women had a score of 61.9 ± 9.3%. The women at the collection/bulking centre had the highest knowledge score along the chain with a mean of 68.8 ± 9.8%.

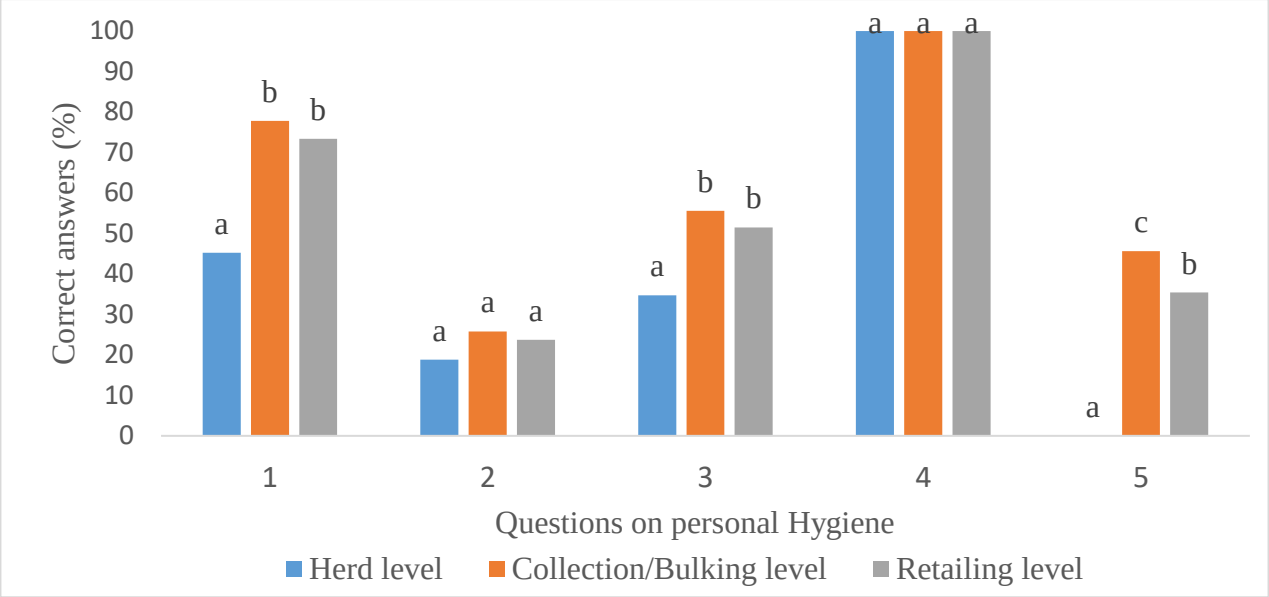
The percentages of camel milk value chain actors who answered questions correctly are presented in Figures 1, 2 and 3. Women at collection centres answered 64.3% of the questions correctly, herdsmen answered 43.3% of the questions correctly while women retailing milk within Isiolo town answered 57.8% of the questions correctly.

Herdsmen showed the greatest variation in score with reference to individual questions. About 66.7% of the questions were scored below average by the herdsmen with only one question being scored above 70%. The women retailing milk scored 26.7% of the questions below the average (50%) while in 33.3% of the questions, they scored above 70.0%. The women at the collection centre in Isiolo town were more knowledgeable with questions; the score below average being 26.7% while questions scored 70% and above were 33.3%.

Knowledge on personnel hygiene

The percentages of correct answers of questions on knowledge on personnel hygiene are shown in Figure 1. The average correctly answered questions on personnel hygiene was 52.5 ± 9.2%. The herdsmen-correctly answered questions were significantly ($p<0.05$) lower than the questions correctly answered by both retailing women and women at the collection/bulking centres.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 17 No. 1
March 2017
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374



Bars with similar letters in the same category are not significantly different at 5%

Figure 1: Knowledge on food safety and hygiene in respect to personnel hygiene along the camel milk value chain in Isiolo, Kenya
1= Milk handlers with unhygienic practice could be a source for milk contamination, 2= Apparently healthy milk handlers might carry microbes, 3= Handling milk when I have a diarrhoea is risky, 4= Should one wash their hands after visiting the toilets and before handling milk, 5= Have you been trained on safe and hygienic handling practice during milking or milk handling?

Knowledge on environmental sanitation and hygiene

The percentage of respondents that correctly answered questions on environmental sanitation and hygiene is shown in Figure 2. The average correctly answered questions on environmental sanitation and hygiene was 52.9 ± 9.3%. The correctly answered questions on sanitation and hygiene for herdsmen was 39.9%, which was below average and was significantly ($p<0.05$) lower than the correctly answered questions by retailing women and women at the collection/bulking centres.

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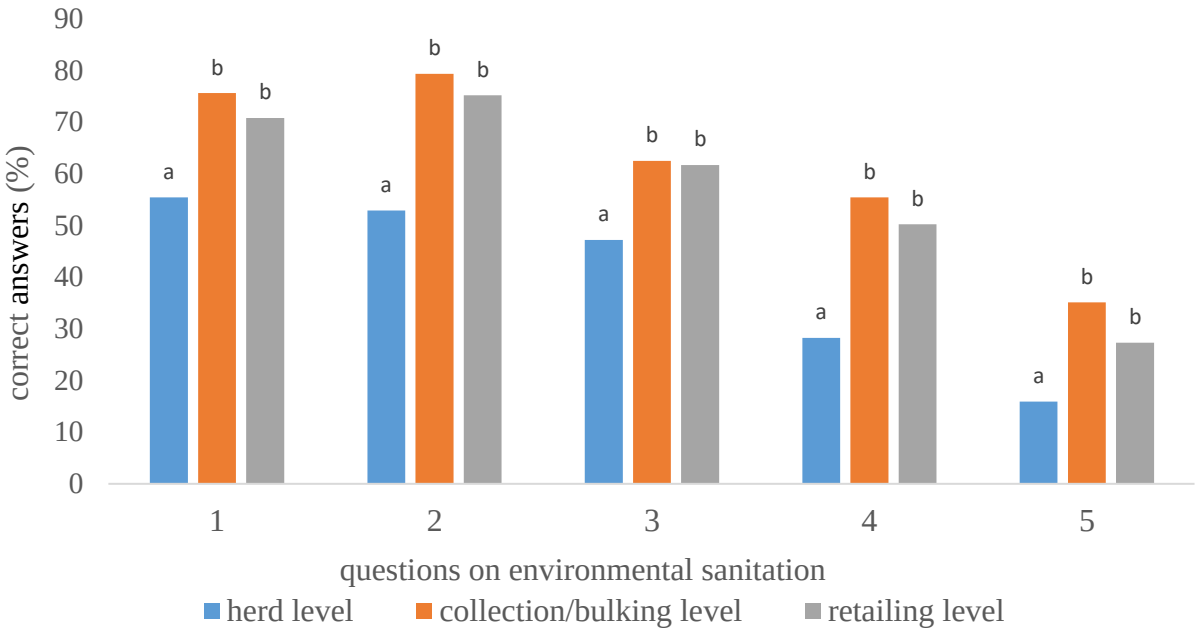

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Figure 2: Knowledge on food safety and hygiene in respect to environmental sanitation and hygiene along the camel milk value chain in Isiolo, Kenya

1= Environmental contamination of milk is highly risky for shelf life of milk, 2= Unhygienic environment can be a source of contamination of milk, 3= Insects such as cockroaches and flies might transmit foodborne microbes to milk, 4= Water can be a source of microorganism contamination of milk, 5= Food pathogens can be seen by the eye

Knowledge on milk spoilage and processing

The percentages of respondents that correctly answered questions on milk spoilage and processing are shown in Figure 3.

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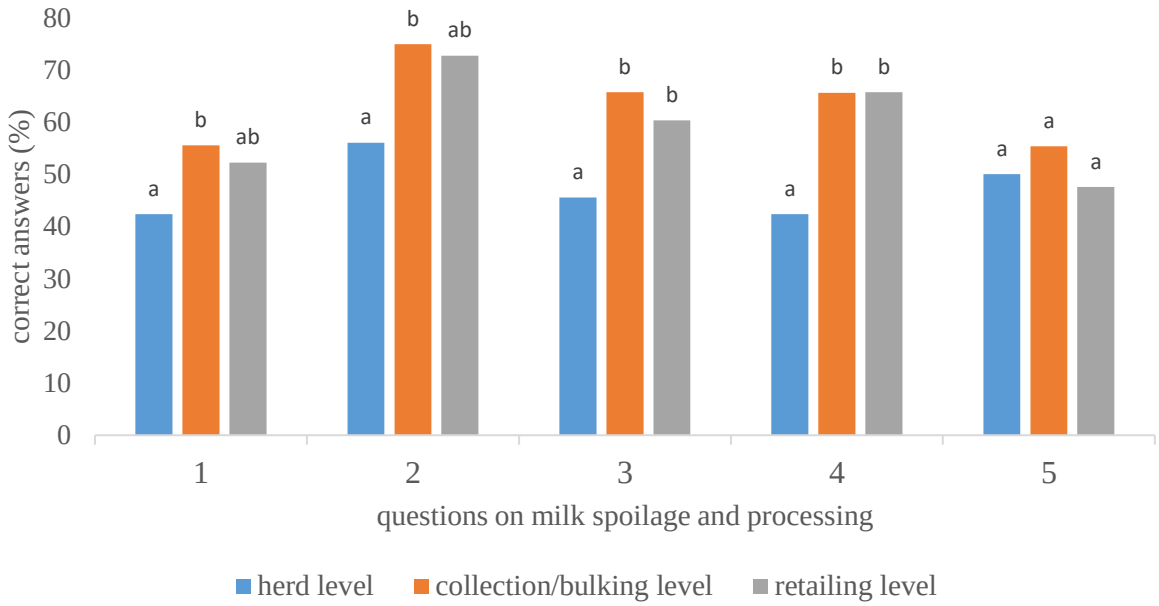

The bars with similar letters in the same category are not significantly different at 5%.

Figure 3: Knowledge on food safety and hygiene with respect to milk spoilage and processing along the camel milk value chain in Isiolo, Kenya
1=Microbial contamination of milk can cause severe disease that can result to hospitalization of an individual, 2= Bacteria multiply quickly at room temperature, 3= Milk spoilage is caused by spoilage microorganisms, 4= Chilling of milk helps retard microbial spoilage of the milk, 5= Heat processing of milk is important

The average correctly answered questions on knowledge on milk spoilage and processing was 56.9 ± 6.9%. This was slightly higher than the knowledge expressed on personnel hygiene and environmental sanitation and hygiene. The herdsmen knowledge on food hygiene and safety was significantly ($p<0.05$) lower than the knowledge for retailing women and women at the collection/bulking centres.

Cleaning of milk handling containers
Milk containers cleaning methods used by actors in the pastoral communities are shown in Figure 4. A majority (above 50%) of respondents reported that cleaning with water then smoking the containers was the most effective method.

About 77%, 54% and 60% of the herdsmen, women at the collection/bulking centres and retailing women, respectively indicated that cleaning then smoke fumigating the containers is the effective method of cleaning. Only 4.7%, 13.8% and 10% of herdsmen, women at the collection/bulking centres and retailing women in Isiolo town, respectively, indicated that conventional cleaning with detergent then sanitizing the containers was the effective method of cleaning. The retailing women's knowledge on effective cleaning method was also very poor as shown in Figure 4. However, a few indicated that smoke fumigation alone without even cleaning the container which had previously handled milk

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was an effective method of cleaning. This can further compromise the quality and safety of the next batch of milk that will be handled in such containers.

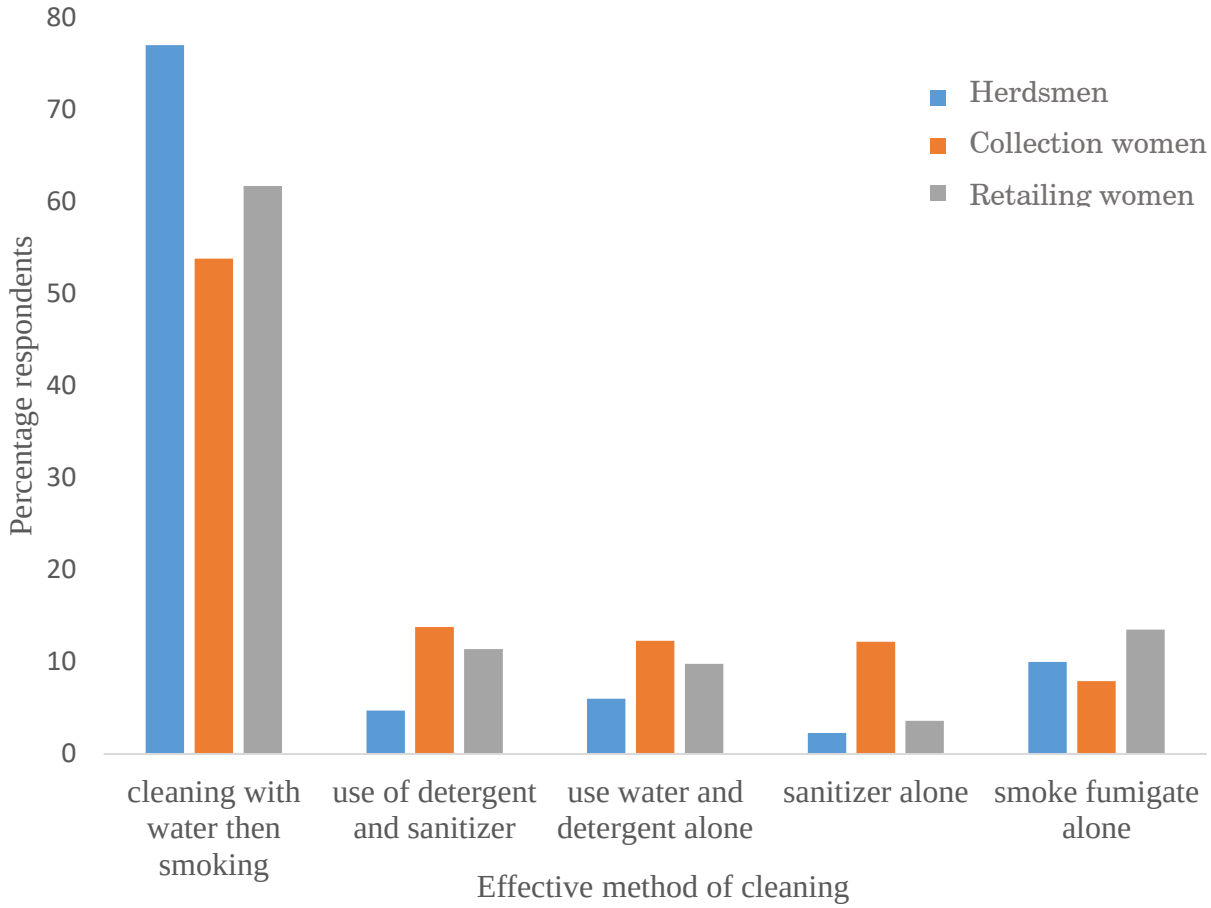

Figure 4: Cleaning practices by the actors along the pastoral camel milk value chain

The results on knowledge of the respondents about practices that would cause milk spoilage are shown in Figure 5. Both the herdsmen (35.7%) and the retailing women (37.1%) indicated that the practice of delaying delivery of the milk to the collection centres may cause spoilage of camel milk while 20.7% of women at the collection point reported that spoilage of the milk is caused mainly due to power shortage which renders the cooling facilities unable to work.

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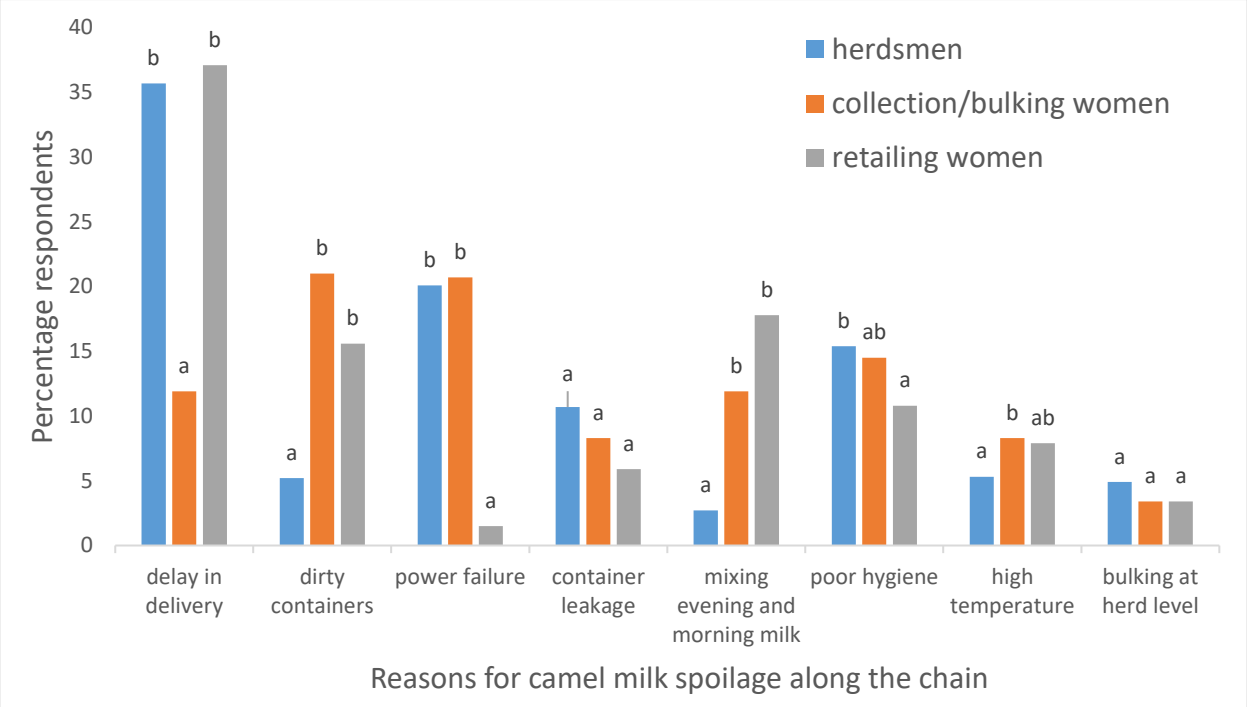

Bars with similar letters in each category are not significantly different at 5%

Figure 5: Reasons given by actors for the causes of camel milk spoilage along the chain

Use of rejected milk along the pastoral camel milk value chain

A crosstab was done between the main cause of camel milk spoilage and the use of such spoiled milk by the actors along the pastoral value chain to establish their food safety practices. The study also established that the pastoralists carried the highest economic loss burden since 70.6% of the women at the collection centre and 47.1% of the women retailing milk would return the spoiled milk to the herd owner hence the greatest loss is incurred by the herds owners (Table 1). About 37.7% of the retailing women and 17.7% of the women at the collection centres use the spoiled camel milk to make *suusac* a product that results from spontaneous fermentation of the camel milk. Those who receive the spoiled milk least use it for family use. The women at the cooling hub used only 8.2% while the retailing women used 15.3% for family consumption. The women at the cooling hub returned 70.6% while the retailing women returned 47.1% of the spoiled milk to camel owners. The cost implication is, therefore, mainly on the herd owners who supply the camel milk to the women at the collection centres and the retailers.

DISCUSSION

Knowledge on food hygiene and safety along the camel milk value chain

The mean score on food safety knowledge of herdsmen was significantly lower ($p<0.05$) than the mean score of the women both at the collection centres and the retailers while the mean scores of women both at the collection centres and those retailing milk were not significantly ($p>0.05$) different. This indicates that higher risks are likely to occur at

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the herd level where the herdsmen are involved. This may lead to a situation where even if the other points along the chain have better food hygiene and safety knowledge, they can do little to eliminate the hygiene risks already introduced at the herd level.

The proportion of questions answered correctly by the herdsmen were significantly ($p<0.05$) lower compared to the questions answered correctly by the women at the collection/bulking centres and women retailing milk in Isiolo town. A study carried out in South Africa by Marais *et al*. [17] on knowledge of food hygiene reported average percentage of correct answers (46.0%), while another study in Ankara, Turkey, reported a mean score of 43.4 ± 16.3% [18]. The above reported knowledge levels are relatively lower than the value reported in the current study (55.1%).

Knowledge on personnel hygiene

The correct scores on healthy individual being carriers of pathogens were 18.8%, 25.8% and 23.7% for herdsmen, women at the collection centres and women retailing milk within Isiolo and its environments, respectively (Figure 1). A study on food hygiene knowledge, attitudes and practices of the food handlers in the military hospitals in Jordan by Sharif *et al.* [16] reported a higher knowledge of 79% correct answers that healthy individuals were able to carry pathogenic microorganisms.

All the respondents answered the question that persons correctly handling milk should wash their hands after visiting the toilets but failed to wash hands before handling milk. This could be attributed to the fact that the respondents were Muslims and that washing hands after visiting a toilet is one of their religious practices.

The herdsmen's knowledge on unhygienic milk handling practices being a source of milk contamination was below average and significantly ($p<0.05$) lower than that of retailing women and women at the collection centres. The average score for the question on handling milk when one has a diarrhoea is risky was 47.3% which was below average. Diarrhoea is usually caused by pathogenic infections and hence the possibility of the person getting contaminated with the pathogens in the process of one relieving him/herself is high. This could result in contamination of the milk. This presents a food safety concern to camel milk consumers and public health.

On average, only 19.5% had been trained on food hygiene and safety issues. This could explain the low knowledge of the herdsmen along the chain. Therefore, training could be an important intervention along the chain to enable the milk handlers to learn how to best maintain hygienic practices which will in turn result in safe milk along the chain.

Knowledge on environmental sanitation and hygiene

Most of the respondents had the wrong perception that foodborne pathogens could be seen with naked eyes. This study showed that 78.2% of the respondents along the camel milk chain wrongly believed they can see microorganisms with their eyes. This is higher than results reported by other studies where between 52.5% and 64.4% of food handlers wrongly believed that they can tell if food was contaminated with food poisoning bacteria by visual, olfactory or taste checks [19 - 22].

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About 45% of the respondents along the chain acknowledged that water can be a source of microorganisms contaminating camel milk. Water sources have been noted as one of the greatest challenges in the pastoral camel milk value chain [15, 23, 24, 25]. Most studies have reported on the need to use potable water in the pastoral camel milk value chain [24, 26]. However, this has not been adopted especially at the milk production level by herdsmen as observed during the current study. This is attributed to scarcity of water sources in the remote grazing/browsing areas where camels are usually milked.

About 57% of the respondents along the chain acknowledged that insects such as cockroaches and flies might transmit foodborne microbes to milk. The herdsmen showed poor knowledge (47.2%) and were significantly ($p<0.05$) lower compared to both retailing women and women at the collection centre. The camel milk handling points are characterized by a lot of flies. The flies at times are found dead or trapped in the milk. This may lead to contamination of the milk due to cross contamination since the flies are also associated with faeces.

About 53%, 79% and 75% of the herdsmen, women at the collection/bulking centres and retailing women, respectively, acknowledged that an unhygienic environment can be a source of contamination of milk. Despite this knowledge among the pastoralists handling the milk, the challenges they faced leaves them with few options. The result is the persistent unhygienic handling practices that have been reported in many studies [13, 15, 23, 25].

Knowledge on milk spoilage and processing

Knowledge on milk spoilage caused by microorganisms was poor despite the main cause of camel milk spoilage in the pastoral value chain being attributed to contamination by microorganisms as reported by Kaindi *et al.* [23]. Camel milk spoilage in the pastoral value chain is as a result of the interaction of several factors including poor hygiene caused by lack of or inadequate potable water, the use of recycled difficult-to-clean plastic containers, and high ambient temperature that facilitates growth of spoilage microorganisms [11, 12,13, 34]. An average of 68% of the respondents acknowledged that microorganisms grow faster under room temperature. With the room temperature being mostly at 25^0C [23], the spoilage microorganisms will grow faster hence faster spoilage of the camel milk.

Despite cooling/chilling being a key means of preserving milk, only women at collection centres (97.5% correct answers) seemed to be informed about chilling of milk retarding microbial spoilage of the milk. Only 42.5% of herdsmen answered this question correctly. Heating of milk enables destruction of pathogens and spoilage organisms hence the milk can keep longer and be safe for consumption.

An average of 50% of the respondents acknowledged that microbial contamination of milk can cause severe disease that can result in hospitalization. Some of the pathogens that have been reported in milk and could result in hospitalization include: *Escherichia coli, Salmonella* spp, *Shigella* spp, *Staphylococcus aureus, Streptococcus pyogenes, Campylobacter jejuni, Listeria monocytogenes, Brucella* spp, and *Yersinia enterocolitica* [27, 28, 29].

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Cleaning of milk containers

Results showed that the actors along the camel milk value chain still believe in the traditional cleaning practices of smoke fumigation of the plastic milk containers. Focus group discussions established that cleaning of the transporting and milking containers is usually delayed with cleaning of the milking containers happening the next day before milking starts while the transporting containers are cleaned in the evening. According to Gran *et al.* [24], to prevent contamination of the milk, hygiene of the personnel and the sanitation of equipment and water are extremely important. This, therefore, requires that effective cleaning and sanitation is done to ensure that both pathogenic and spoilage microorganisms are effectively destroyed to ensure that the next batch of milk will not be contaminated.

The practice of mixing evening milk and the morning milk has been reported in the pastoral value chain by Wayua *et al*. [30]. This practice has been significantly reduced as evening milking is avoided by most herders except for usage at the herd level as established in the current study. Poor hygiene has been reported as one of the main reasons causing spoilage of the camel milk along the pastoral value chain [12, 23, 31, 32]. This seems to be viewed differently by the actors along the chain whose hygiene practices the study showed to be poor. The herdsmen (15.4%), collection women (14.5%) and retailing women (10.8%) attributed milk spoilage to poor hygiene practices. The use of the rejected camel milk for consumption either at home or for making *suusac* for sale poses a food safety risk to the public exposed to such milk, due to the likelihood of pathogenic organisms being present. This indicates poor knowledge of the actors who receive milk from the pastoralists. Poor hygiene is one of the major ways of introducing pathogens to the milk [33].

It was also established that no actor used fresh milk for making *suusac* and that only milk that was rejected and could no longer sell as fresh milk was used for making *suusac*. The milking of the camels was also done without consideration of whether the camel was sick or not. The herders consume the raw milk directly from the camel without pasteurization; this could increase the food safety risk if the milk was from a camel having mastitis. The knowledge on withdrawal period after administration of veterinary drugs was also poor since no one observed it. This may pose a risk of having higher antibiotic drug residues in the milk.

CONCLUSION

Food safety and hygiene knowledge along the pastoral camel milk value chain was found to be average. The food safety risk is compounded by the low understanding of the spoilage and pathogenic microorganisms by the pastoral camel milk actors which is likely to increase milk contamination. The consumption of spoilt/rejected milk along the chain presents an important public health concern.

To ensure milk hygiene and safety, hygiene procedures need to be enforced along the camel milk value chain which includes hand washing procedures, milk container sanitization procedures and udder/teat washing procedures. The actors along the camel

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milk pastoral value chain need training on food safety and hygiene practices to improve their knowledge and practices regarding food hygiene and safety. Due to the poor education background of most of the actors, the training should be presented in terms of posters and videos. For medium term effect, the training should be repeated periodically to refresh the actors' knowledge.

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Table 1: The relationship between the main cause of spoilage and camel milk use along the camel milk value chain in Isiolo

Main cause for camel milk poor quality	Use of spoiled milk along the camel milk value chain						Total	
	Family use		Make *suusac*		Return to owner/pastoralists			
	Retailing Women (%) N=75	Collection Women (%) N=85	Retailing Women (%) N=75	Collection Women (%) N=85	Retailing Women (%) N=75	Collection Women (%) N=85	Retailing Women (%) N=75	Collection Women (%) N=85
Delay in delivery	1.2	1.2	4.7	2.4	4.7	7.1	10.6	10.7
Dirty containers	3.5	1.2	10.6	0	9.4	16.5	23.5	17.7
Poor hygiene	2.4	2.9	8.2	6.9	11.8	12.3	22.4	22.1
Container leakage	2.4	1.2	1.2	0	2.4	4.7	5.9	5.9
Bulking milk from the same herd	2.4	1.2	4.7	0	2.4	5.9	9.4	7.1
High environmental temperature	2.4	0	1.2	2.4	4.7	4.7	8.2	7.1
Mixing morning and evening milk	1.2	2.4	3.5	3.5	11.8	20	16.5	25.9
Power outage	0	0	3.5	3.5	0	0	3.5	3.5
Total	15.3	10.1	37.7	18.7	47.1	71.2	100	100

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