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Effect of Sisal Foil Wrapped Milk Containers on Quality Parameters of Camel Milk Marketed in Borana Zone, Southern Ethiopia

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Keywords: camel milk, marketed milk, milk container, milk quality, sisal foil and borana.

I. Introduction

Milk is a marvel of nature and a very nutritious biological fluid which is produced by lactating animals to feed their offspring naturally. However, milk and milk products are indispensable components of the food chain of human being throughout the world. In most part of the world cattle milk is consumed much than other milk sources like Goats, camel, buffalo and sheep. Recently, because of its outstanding performance in the arid and semi-arid areas of south-east lowlands of Ethiopia where browse and water availability are limited, pastoralists rely mainly on camels for their livelihood (Bekele et al 2002). In these areas, camels are mainly kept for milk production and produce milk for a longer period of time even during the dry season when milk from cattle is scarce. In most pastoralists, camel milk is always consumed either fresh or in varying degrees of sourness of raw state without heat treatment and thus can pose a health hazard to the consumer.

Though it is dependent on genetics and environmental factors, camel milk is composed of much of water and other chemicals different in their composition. One of the parameters in camel milk quality is the accepted level of composition of these chemicals like the fatty acid, protein and lactose content, the pH level of the milk, and its test and texture. The milk quality can be affected at different levels starting from the physiology of the animals to be milked, and event of milking, collecting, transporting, processing and distribution of milk. The study area is characterized by lack of refrigeration facilities during milking and transportation. For instance the report of YONAD Business Promotion and Consultancy Service (2009) revealed that utilizing plastic containers for camel milk transportation from central Borana to Kenya border is the primary causes for milk quality deterioration since milk is highly perishable product. Therefore, having a due attention to total quality aspects of milk production and consumption; quality detection and safety precautions became of paramount importance. Thus, it was necessitated to develop refrigerating technology from locally available materials like wrapping milk containers by the foil that was obtained from the plant species so called sisal. Hence, this study was designed to evaluate the effectiveness of Sisal foil wrapped milk container that was soaked in water on reducing microbial growth and increased shelf life of the camel milk, transported long distance exposed to sunlight in Borana pastoral area.

II. Material and Methods

a) Study area description

The study was carried out in pastoral communities of southern Ethiopia, Borana Zone of Oromia Regional State during the dry and wet seasons of 2011 to 2012. The sites selected for the study purpose included Surupa kebele from Yabello district and Moyale town of Moyale district. Surupa kebele, the

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initial site, is located at about 50km North of Yabello town on the high way to Addis Ababa whereas Moyale town, the terminal site, is situated at 200km South of Yabello town at the border of Ethio-Kenya. Thus, the focus of the study was milk transported over 250 km distance from the above location to Moyale town.

b) Methods of sample collection and laboratory analysis

Samples of camel milk were taken, transported and analyzed following standard procedure (Richardson, 1985). Fresh morning camel milk samples were collected at farm level (Olla). Pastoralists were pre-informed to prepare, as possible as, clean unadulterated milk. All the milk samples collected from the pastoralists were tested for primary quality tests which included Specific gravity, Organoliptic test (smell, color and appearance of the milk), and Alcohol test). Those which were negative for the tests were considered as good quality milk and mixed to make homogenous milk before transferring to treatment containers for the initial quality test that was designed as:

T1= 4 Local Milk Containers (currently under utilization by the community)

T2= 4 Unwrapped New Plastic Milk Container

T3= 4 Wrapped New Plastic Milk Container

Except for the four local ones, those were fumigated and handled according to the community's indigenous knowledge; the remaining containers (wrapped and unwrapped new plastic containers) were sterilized using hot water. Variations in terms of where the containers had been placed on the vehicle were controlled as much as possible. Therefore, care was taken on how the milk containers were placed on the vehicle and deliberate efforts were made to ensure the containers were placed systematically every time in a repeatable way so that some received more air movement and sun light and others less. Thus, the above treatments were sub-divided as it was labeled below with regard to their placement pattern on the vehicle to conduct quality test at the terminal point:

- NMEC (Most Exposed Container)
- NLEC (New Less Exposed Containers)
- LMEC (Local Most Exposed Container)
- LLEC (Local Less Exposed Container)
- WMEC(Wrapped Most Exposed Container)
- WLEC (Wrapped Less Exposed Container)

Mixed and homogenized 1liter of milk sample was transferred to each of the container. Thermometer reading was taken from each container before transportation. Half of the containers (2 from each treatment) were kept on the upper layer of the entire container properly arranged and loaded to the car used for human transportation, in a way it was freely exposed to the sunlight. Whereas the remaining half from each treatment were loaded at the bottom of the layer of the container loaded on the car to prevent direct exposure to sun light and strong wind pressure. 100ml of samples representing the respective treatment was collected in well sealed bottles for utilizing as a control and kept under the refrigerator temperature in Ice box to be utilized as a control. The sample was immediately taken to the laboratory station of Yabello Pastoral and Dryland Agriculture Research Center.

c) Terminal market (Moyale) milk quality

At the terminal point where the milk is sold Plat form tests (Organoleptic, Alcohol and Clot on boiling) for each treatment sample was performed and temperature reading was also taken. For Further quality test, 100ml sample of milk from each treatment was collected and kept under refrigerator temperature in Ice box and brought to aforementioned laboratory station.

d) Laboratory analysis

i. *Titratable acidity*

The titratable acidity of all the samples (From the farm and terminal market) was determined by the quantity of a standard alkaline solution (0.1 N NaOH) which is required to neutralize the milk in the presence of phenophitaline.

ii. *The resazurin test*

Resazurin solution was prepared as per the standard procedure of one ml of the solution was placed in sterile test tubes then 10ml of the milk samples were added to each test tube. The samples were incubated at 37°C and result was recorded at 10min., 1hr.and 3hrs interval.

iii. *Microbial count*

Aerobic plate count was done within 12 hr of arrival of the samples at the laboratory. Enumeration of total aerobicmesophilic bacteria was done after plating 1 ml of the 10-5 dilution of the samples onto Standard Plate Count Agar. The agar plates were incubated aerobically at 35oC for 48 hr with replications. After incubation colony was count by counter and result was expressed as colony forming unit per one ml of milk (cfu/ml).

e) Data analysis

Descriptive statistics was utilized to compute the required data of the treatments, and the independent t-test was also employed to analyze the data of the treatment along the seasons of the area.

III. Results and Discussion

a) Quality of milk at producer (Olla) and terminal market

Having all the experimental containers the team was arrived at village (Olla) from where the sample was

taken. The wrapped container just right wrapping was depicted in the picture below.

Figure 1 : Pictures of containers during wrapping at Yabello Pastoral and Dryland Agriculture Research Center, and arranged experimental containers for sample collection at Surupa kebele

It was identified that camel milk was pooled together by producers of the respective villages (Olla) of Borana zone to be availed for domestic market and/or Moyale town to be consumed by the dwellers of Ethiopian Moyale or crossed the border for Kenyan Moyale residents. Mode of transportation was that milk with plastic containers was solely loaded on the back of the vehicles for human transportation. There is also one Isuzu truck which transports 2500 liter milk (up to 250 Jerry cans with a volume of 10 liter) daily. The milk reaches to its destination in the afternoon between 1:00pm – 2:00pm. The following pictures depict the plastic jerry cans with collected milk that has been loading for transporting to Moyale town and backing the empty containers to Surupa PA.

Figure 2 : Systematically arranged containers for transporting camel milk from Surupa kebele to Moyale town and backing the empty containers to Surupa

The quality test for camel milk collected from producers (Olla) and after it reached a terminal market (Moyale) during both seasons of the area were conducted as presented in Table 1 and Table 2, respectively. The smell of milk both during the dry and wet seasons was smoky since all the pastoralists in the study area have been smoking their milk containers for various purposes (Table 1). For instance, smoking milk containers has been reported to exert anti-microbial properties and prolong the shelf life of milk (Ashenafi 1996). It was clearly observed from the physical derbies in the milk that pastoralists produce their milk under none hygienic environment. According to Abdurrahman (1995), poor management and unhygienic milking practices prevalent in the traditional husbandry systems, which include tying the teats with soft barks to prevent the calf from suckling, tick infestations and cauterization of the udder and skin, are few of the factors responsible for contamination of milk. There was specific gravity variation of camel milk during the dry and wet seasons of the study area probably due to moisture content difference along the seasons ($p < 0.01$). In this study it was observed that the specific gravity during the dry season ranged from 1.020-1.022 at 20°c calibrated lactodency meter (Table 1). However, it ranged from 0.995-1.002 at 20°c calibrated lactodency meter. At initial point (Olla) all the samples collected were negative for alcohol test that was evidence for no or very low production of acid at farm level which indicates the freshness of the milk. Significant temperature variation

was observed ($p<0.01$) for the milk in the wrapped and unwrapped containers mainly due to the unwrapped containers' absorption of the environmental temperature. Similarly, there was also variation in temperature of milk in unwrapped containers those were labeled as NC and LC, during the two seasons of the study area. That might be due to the fact that environmental temperature of wet season was cooler than dry season, particularly in the morning while we collected the sample. The relatively lesser temperature rise for wrapped container that was labeled as WNC during wet season was principally because of the cooling nature of wrapping.

The rise in temperature was relatively lower for wrapped containers and during the wet season as well (Table 1). It was possible to observe that the samples with higher temperature were positive for alcohol and clot-on-boiling test (Table 1 and Table 2). This result is in line with the report of 0'Connor (1995) which states that temperature is the most determining factor for milk fermentation and hence quality deterioration.

Table1 : Primary quality tests of camel milk at producers (Olla) during dry and wet seasons of Borana zone

Sample No	Dry season			Wet season			Dry season		Wet season	
	Smell	Color	Appearance	Smell	Color	Appearance	Specific gravity	Alcohol (68%)	Specific gravity	Alcohol (68%)
1	Smoked	Yellowish white	Physical Derbies	Smoked	Whitish	Physical Derbies	1.020	-Ve	0.995	-Ve
2	Smoked	Yellowish white	Physical Derbies	Smoked	Whitish	Physical Derbies	1.021	-Ve	0.997	-Ve
3	Smoked	Yellowish white	Physical Derbies	Smoked	Whitish	Physical Derbies	1.022	-Ve	1.002	-Ve
4	Smoked	Yellowish white	Physical Derbies	Smoked	Whitish	Physical Derbies	1.021	-Ve	1.001	-Ve
5	Smoked	Yellowish white	Physical Derbies	Smoked	Whitish	Physical Derbies	1.020	-Ve	1.001	-Ve

Temperature of pooled sample of camel milk within the three treatments at the initial point (Olla) during the dryand wet seasons

Type of Container	Code for Container	Dry season(26°C[2])	Wet season(21°C[1])
Wrapped New Container	WNC	21°C	19°C
Unwrapped New Container	NC	24°C	20°C
Local Container	LC	25°C	24°C

Test for various Organoleptic and temperature measurement of milk at the terminal market (Moyale town) revealed that there was some similarity and discrepancy for wrapping and not wrapping the containers. The discrepancy also held for the seasons of the study site as summarized in Table 2. All the wrapped and soaked containers stayed negative for both alcohol and clot on boiling test at the terminal milk market during both seasons (Table 2). At the terminal market soaked containers relatively stayed cool than unsoaked containers. The exposed milk containers had significantly higher temperature than less exposed containers ($p<0.01$).

Table 2 : Primary quality tests of camel milk at terminal point (Moyale town) during the dry and wet seasons of Borana zone

Sample code	Dry Season(30°C*)						Wet Season (25°C[2])					
	Alcohol Test	Clot on boiling	Smell	Color	Appearance	Milk Temperature	Alcohol Test	Clot on boiling	Smell	Color	Appearance	Milk Temperature
WMEC	-ve	-ve	Smoked	Yellowish white	Physical derbies	27°C	-ve	-ve	Smoked	Whitish	Physical derbies	24°C
WLEC	-ve	-ve	Smoked	Yellowish white	Physical derbies	25°C	-ve	-ve	Smoked	Whitish	Physical derbies	23°C
LMEC	Turbid/ Sediment	+ve	Smoked	Yellowish white	Physical derbies &Minor curdling	33°C	Turbid/ Sediment	+ve	Smoked	Whitish	Physical derbies	28°C

[1] Indicates the environmental temperature of the study area (At initial point)

LLEC	Sediment	+ve	Smoked	Yellowish white	Physical derbies	30°C	-ve	+ve	Smoked	Whitish	Physical derbies	26°C
NMEC	Clear sedimentation	+ve	Smoked	Yellowish white	Viscous	34°C	Turbid/ Sediment	+ve	Smoked	Whitish	Physical derbies &Minor curdling	30°C
NLEC	Sediment	+ve	Smoked	Yellowish white	Viscous	30°C	Turbid/ Sediment	+ve	Smoked	Whitish	Physical derbies &Minor curdling	28°C

WMEC: Wrapped container exposed to Sun light; WLEC: Wrapped container less exposed to Sunlight; LMEC: Local container exposed to sunlight; LLEC: Local container less exposed to sunlight; NMEC: New container exposed to sunlight; NLEC: New container less exposed to sunlight.

Milk of other treatments with unwrapped and unsoaked containers was remained positive for alcohol and clot-on-boiling test. That might due to the development of lactic acid from milk fermentation because of exposure the containers to sun light. The result was proved according to the report of 0'Connor (1995) which states that alcohol test is an alternative method of measuring the acid accumulation of milk since it is more sensitive for acid than clot-on-boiling test.

b) Laboratory sample analysis result

i. *Titratable acidity*

The acidity value of samples from terminal site (Moyale town) during both seasons was evaluated at N° (0.1 NaOH) as summarized in Table 3.

Table 3 : Titratable acidity value of camel milk from terminal site during the dry and wet season of Borana zone

Sample code	Dry Season		Wet Season	
	N° (0.1 NaOH)	Lactic acid	N° (0.1 NaOH)	Lactic acid
WMEC	2.30	0.230	2.28	0.228
WLEC	2.28	0.228	2.27	0.227
LMEC	2.38	0.238	2.35	0.235
LLEC	2.35	0.235	2.32	0.232
NMEC	2.40	0.240	2.36	0.236
NLEC	2.36	0.236	2.33	0.233
Control	2.25	0.225	2.25	0.225

WMEC: Wrapped container exposed to Sun light; WLEC: Wrapped container less exposed to Sunlight; LMEC: Local container exposed to sunlight; LLEC: Local container less exposed to sunlight; NMEC: New container exposed to sunlight; NLEC: New container less exposed to sunlight.

The lactic acid secretion of milk in the wrapped containers was relatively lower than unwrapped during both seasons of the study site. On the other hand, the containers with no wrapping stimulated the milk to produce extra lactic acid which strongly deteriorates the quality parameters. The secretion of lactic acid during the wet season was significantly lower than the dry season ($p<0.01$). The same was true for less exposed containers than the most exposed ones. The results were in line with the report of T. Ahmed and R. Kanwal (2004) which states that when camel milk is left to stand and heated moderately, the acidity rapidly increases due to the presence of lactic acid producing bacteria.

ii. *Resazurin test*

The dye reduction value of the whole representative sample with three time interval was only analyzed for dry season due to chemical constraint the researcher faced to repeat during the wet season of the study area. The milk samples didn't show any significant variation in color change during the first 10min whereas after an hour the new plastic container that was exposed to sun light was totally changed to pink (Table 4).

Table 4 : Resazurin test of camel milk from terminal site during the dry season of Borana zone

Sample Code	10min.	1hr.	3hr.
WME	Light purple	Light purple	Light purple
WLE	Light purple	Light purple	Light purple
LME	Light purple	Purple pink	Whitish pink
LLE	Light purple	Light purple	Pink
NME	Light purple	Pink	White
NLE	Light purple	Slightly Purple pink	Pink
Control	Light purple	Light purple	Light purple

After 1hr the samples in unwrapped new containers as well as in local containers there were color change which is an indication of becoming poor in quality. Even after 3hrs incubation the samples in wrapped containers remained unchanged. In the contrary the dye was totally reduced in the sample from new plastic container that was exposed to sun light that showed bad quality milk. While, the local containers that

[2] Indicates environmental temperature of the study area

was most exposed to sun light was changed to whitish pink after 3hr of incubation. Whereas the local containers were in better position than new plastic containers this might be due to the fact that the containers were well smoked. Compounds released from smoking wooden trees namely Olea africana (Egeresa) and Balanites galbara during smoking of the containers may be responsible for the longer shelf life of camel milk (Eyassu, 2007).

iii. *Total microbial load*

The average microbial count for the samples of camel milk under different containers of the treatments was undertaken for dry season of study area despite not done for the wet season due to the laboratory equipment damage during that season. The researchers did not differentiated the micro-organisms were economically important or not than counting the load. The result showed that the milk samples kept in new plastic containers those were most exposed to sun light had the highest microbial load (6 x 105) followed by the local containers those were most exposed (4 x 105). Whereas wrapped containers had a positive effect on maintaining good quality of milk during transportation. The microbial load difference might be associated with post harvest handling. For instance, at bulking and market centers, microbial contamination increased to almost 100% cfu/ml for the camel milk being stored at high temperature on transit to other distant markets from farm environment (Matofari J. W., et al, 2013).

Table 5 : Microbial count under the different treatments of dry season of Borana zone

Sample Code	*Colony Forming Unit (CFU/ml of milk*
WME	2.0×10^4
WLE	2.0×10^4
LME	4.0×10^5
LLE	3.0×10^4
NME	6.0×10^5
NLE	1.5×10^5
Control	1.0×10^4

IV. Conclusion and Recommendations

The result of the study enabled us to generally conclude that wrapping the containers has an importance in maintaining the quality of milk transported long distance exposing to sun light. On the other hand wrapping containers has a great contribution in minimizing microbial load and lactic acid production as of the fermentation. Hence, the stakeholders responsible for milk quality monitoring and enhancement have to be strengthened for scaling up this technology since it is found to be effective in maintaining the quality of milk involved in market being transported long distance.

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