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Fluid Milk Processing and Marketing for Sustainable Development of the Camels' Herders Communities*

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Abstract

Camel milk has an important role in the nourishment of the pastoralist as it contains all the essential nutrients found in bovine milk. However most of camel milk produced is consumed locally as it does not reach the urban markets because of many constraints. Currently there are increasing demands for camel milk among the urban settlers, which are mainly due to the increase awareness on its medicinal values. Some of spoilage and potential pathogens are detected in raw camel milk samples, although raw camel milk has longer shelf life than that of cow milk. This longer shelf life can be further extended when heat treatment is applied; which is lacking among most of the pastoral societies. Addition of lactoperoxidase enzmes system and some herbal plants were also found to improve the keeping quality of camel milk. These safe preservation methods improve the microbial loads and increase the shelf life of camel milk with little adverse effect on the compositional content including vitamin C. Hence it is possible to commercialize camel milk from remote areas to urban consumers nationally and as an international trade. However this necessitates initiation of milk collection centers and milk processing units equipped with facilities and to draw the attention of camels' herders' communities to accept marketing of their milk, which would result in improving their lifestyle. Some of the governmental strategies should also be directed towards supporting the initiatives by providing facilities and services and to state regulatory standards in order to cope with the international milk quality measures.

Key words: Fluid camel milk, preservation, commercialization

Introduction

In Sudan, camels are kept mainly under the traditional nomadic production system, semi nomadic and transhumant production system, as well as the newly adopted intensive and semi intensive production system (Shuiep and El Zubeir, 2012). El Zubeir and Nour (2006) documented that camel husbandry make a significant contribution to national economics in Khartoum State and Sudan, However unfortunately it is very difficult to evaluate the economic significance of camel milk production, since almost all milk produced is to satisfy the households and herders.

Sudanese she camels produce daily milk yield as estimated from half of the udder was found to range from 2.28 to 4.72 liters and

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total milk yield varies from 820 to 2400 liters per lactation of 12-18 months in camels reared under nomadic system (Bakheit *et al.*, 2008). Camel milk is often the only regular food source for camel owners and nomadic people (Musa *et al.*, 2006), as it may contribute up to 50% of the nutrient of the pastoralist people (El Hag *et al.*, 2003). Traditionally the most common forms of consumption are either fresh or fermented (Farah *et al.*, 2007).

Camels represent the back bone in the economical live of *abbala* (camel herders) in Sudan, either by selling male camels in local markets or by exportation (Shuiep and El Zubeir, 2008). Moreover, the recent awareness of the nutritional and the medicinal value of camel milk, give way to more commercially oriented attitude by *abbala* in Khartoum State Shuiep *et al.*, 2013). However the milk which produced by those *abbala* is not processed into products (Shuiep and El Zubeir, 2006).

Pasteurization is adequate for public health assurance of milk safety provided that good manufacturing practices are followed (Holsinger *et al.*, 1997). Camel milk antimicrobial factors were significantly ($P \leq 0.01$) more heat resistant than cow and buffalo milk proteins (Wernery, 2005). Hassan *et al.* (2006) found pasteurization of camel milk before its fermentation into Gariss improved the microbiological content and increasing the shelf life of the product.

Camel milk; which is the main valuable food resources for the nomads in Sudan (Muas *et al.*, 2006) is usually drunk fresh or fermented (Bakheit *et al.*, 2008 and Suliman and El Zubeir, 2013). However heating of milk is not practice among the pastoralist as they believed that camel milk is produced ready cooked from the udder. Hence the present study aimed to highlight the importance of heating camel milk in order to have a safe product with longer shelf life and to review other alternative methods for preserving raw milk. The effect of heating on the nutritive components of camel milk is also discussion, interventions and recommendations for outcomes of the findings are reflected to the camel herders' communities and the concerned agencies.

1. Microbial load of camel milk

The counts of total bacteria and coliform in raw camel milk samples from semi intensive system were higher compared to the traditional systems (Table 1). Production of camel milk under nomadic systems showed high microbial loads in various countries; Semereab and Molla (2001) in Ethiopia (4×10^5); Wernery *et al.* (2002) in UAE ($< 1.0 \times10^5$); Khedid *et al.* (2003) in Morocco (5×10^4) and Karimuribo *et al.* (2005) in Tanzania (8.9×10^5 - 1.0×10^7). The high total counts indicate low quality of some raw camel milk samples (Shuiep *et al.*, 2007). The contamination might be due to the poor hygiene and environmental contamination of raw camel milk (Younan 2004) and the milking procedures (Shuiep *et al.* 2007). Moreover the high coliform count could be due to contamination with feacal material, improper sanitation, and/ or mastitis infection (Murphy and Boor, 2000).

The yeast and moulds count of raw camel milk samples from the semi intensive system were higher compared to the traditional systems. The samples from the traditional systems were taken directly from udder after application of sanitary measurements (Shuiep *et al.*, 2007). Whereas the samples representing the semi intensive system were investigated after refrigeration of milk as commonly the camel milk intended for commercialization is kept refrigerated. The presence of psychrotrophic bacteria might be due to the cold storage, which is lacking among camel owners in the traditional systems.

On the other hand, the raw camel milk may contain potential pathogenic microorganisms like *S. aureus* and *E. coli* (Sheuip *et al.*,

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2007). Moreover Sheuip *et al.* (2009) reported on the toxin genes isolated from the milk of apparently healthy she-camels in Sudan. Similarly Meile *et al.* (2009) found healthy raw and fermented camel milk contain more than 10^7 cfu/ml for *Enterococcus spp*., *Staphylococcus aureus*, *Streptococcus agalactiae* and *Streptococcus bovis*. Those isolates showed high resistant towards tetracycline. Younan *et al.* (2001) isolated *Streptococcus agalactiae* and *Staphylococcus aureus* as causative agents of mastitis from she-camel. El-Demerdash and Al-Otaibi (2013) detected *S. aureus, Salmonella typhemurium* and *E. coli* using PCR in camel milk collected from farmers vendors in Al-Ahassa area of Saudi Arabia.

Table 1: Comparison between some microbiological loads of raw and heat treated camel milk

Microbial measurements	Traditional systems	Semi intensive system		
	Raw milk	Raw milk	LTLT	HTST
Total bacterial count	1.22×10^8	3.02×10^{10b}	9.4×10^{6a}	7.6×10^{6a}
Coliform count	1.70×10^7	1.1×10^{7b}	4.2×10^{5a}	4.09×10^{5a}
Yeast and moulds counts	2.54×10^4	5.08×10^{5b}	1.1×10^{4a}	1.3×10^{4a}
Psychotropic bacterial count	0	1.7×10^{8b}	6.7×10^{5a}	7.7×10^{5a}
Thermoduric bacterial count	-	1.3×10^{8b}	6.2×10^{5a}	6.1×10^{5a}

LTLT: Low temperature long time
HTST: High temperature short time

2. Effect of heat treatment on microbial content of camel milk

The decrease was observed in the means values of microbial measurements (total bacteria, coliforms, total yeast and mould, psychrotrophic bacteria, and thermoduric bacteria) after heat treatment of camel milk samples (Table 2). Moreover non significant variations between the microbial the measurements were obtained using the two procedures of pasteurization. Similarly El Zubeir *et al.* (2008) found lower microbial loads when ccomparing raw and pasteurized milk of the Western Cape, South Africa. Harding (1999) reported that heat treatment is known to improve the quality of dairy product by killing the pathogenic microorganisms. Higher microbial load were observed in the Gariss samples collected from both nomadic and transhumance camel herders (Hassan *et al.*, 2008 and El Zubeir and Ibrahim, 2009) compared to those made in the laboratory after heating the camel milk (Hassan *et al.*, 2006 and El Zubeir and Ibrahim, 2009). However the non complete destruction of organisms after application of heat treatment supported Attia (2001) reported that more heat and time are required for pasteurization of camel milk. Gnan *et al.* (2013) reported that the increase of the microbial loads during storage was more obvious in goat and cow milk compared to camel milk. This might be because of the presence of protective factors in camel milk (Elagamy *et al.*, 1992; Wernery *et al.*, 2005 and Gnan *et al.*, 2013).

3. Effect of lactoperoxidase and some herbal plants on camel milk quality

The addition of lactoperoxidase enzymes system resulted in increasing the shelf life of camel milk both at room and refrigerator temperature (Table 2). The LPS treated camel milk samples that kept at room temperature showed comparable result to the refrigerated control samples. This might be because the antimicrobial effect of the LPS has been proved (McLay *et al.*, 2002; Dufour *et al.*, 2004; El Zubeir *et al.*, 2006; Dajanta *et al.*, 2008; and El-Demerdash and Al-Otaibi,

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2013). Hence the LPS could be a method of milk preservation when cooling facilities are not available (Lambert 1993; Seifu *et al.*, 2005 and El Zubeir and Hassan 2006). El Zubeir (2012) concluded that because camel milk showed superior quality compared to cow's milk, camel communities' herders in arid and semi zones should be involved in the field application of LPS in order to encourage them to collect and utilize their valuable camel milk.

The heat treatment of camel milk showed longer shelf life compared to raw milk as shown in Table 2. This might be due to the reason that heat treatment of milk is used to kill the pathogens and the thermoduric organisms in raw milk (Harding, 1999). Higher keeping quality (20 days) was found by Mohamed and El Zubeir (2012) compared to Wernery (2008) who found that shelf life of pasteurized camel milk kept at 4°C was 10 days. Moreover Gnan *et al.* (2013) reported that the shelf life of pasteurized camel milk show stability in total acidity until 46 days of storage at 4°C.

The anise and cardamom extending raw camel milk shelf life for up to 10 days (Table 2). Moreover they can be used for camel milk as food additives at level of 0.05 as natural flavoring and tasting (Abdelatti *et al.*, 2013).

Table 2: The effect of lactoperoxidase enzyme system (LPS) on the keeping quality (Shelf life/day) of the camel milk (Means± SD days)

Preservation methods	Storage	Refrigeration	Room
Treated by LPS	Treated by LPS	14.67± 4.04	11.00± 3.61
	Control	11.33± 2.31	2.33± 0.58
Treated by herbs	Control	-	3 days
	Spearmint (*Mehtha Spicata*)	-	6 days
	Anise (*Pimpinella ansium*)	-	10 days
	Cardamom (*Elettaria cardamoum*)	-	10 days
Heat treatment	Raw (control)	7 days	-
	Heat treated	20 days	-

The use of herbs and spices as antioxidants is not only important for the health of the animals, but also for the oxidative stability of their products (Frankic *et al*., 2009). Agaoglu *et al*, (2005) reported on the antimicrobial activity of cardamom seed against different microorganisms. Calsamiglia *et al.* (2007) reported on the antimicrobial properties of anise. Spearmint also contains antibacterial, antioxidant and antifungal activities (Kaushiket *et al*., 2003; Mimica-Dukic *et al*., 2003). Abdelatti *et al.* (2013) concluded that the anise and cardamom maybe binomial for future industry for camel milk. El Zubeir *et al*. (2005) observed better quality of Sudanese fermented milks when using spices like black cumin and fenugreek. Suliman and El Zubeir (2013) found that ginger (*Zingiber officinale*), galangal (*Zingiber officinale*), black cumin (*Nigella sativa*), Ffenugreek (*Trigonella foenum-graecum*) and onion (*Allium cepa*) were added by nomadic women camel herders in order to improve their fermented milk. Moreover El-Demerdash and Al-Otaibi (2013) recommended the use of natural plants oil, especially those which are available in the

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area of camel milk production for improving its quality.

4. Chemical composition of camel milk

The data in Table 3 showed that the major milk constituents vary according to the different production systems, which supported Bakheit *et al.* (2008) and Konuspayeva *et al.* (2009). Several factors such as feeding conditions (Mehaia *et al.*, 1995 and Khaskheli *et al.*, 2005), stage and number of lactation (El-Amin *et al.*, 2006 and Faye *et al.*, 2008), geographical origin (Konuspayeva *et al.*, 2009) and seasonal variations (Khaskheli *et al.*, 2005; Haddadin *et al.*, 2008 and Shuiep *et al.*, 2008) were reported to influence camel milk composition. The data presented in Table 3 were also in accord to Ramet (2001) who added that the dry matter content of camel milk varies according to the origin of camel milk and that the dry matter, fat and protein content of camel milk were lower than that of cow's milk.

Higher level of camel milk acidity was reported by El Zubeir and Ibrahim (2009) compared to those found by Sheiup *et al.* (2008) and Hessain *et al.* (2013) as shown in Table 3. This could be due to the reasons that most of the camels are located in the dry and semi dry areas, which are far away from consumption areas (El Zubeir and Ibrahim, 2009). Sheiup *et al.* (2008) took the samples directly from the udder after application of sanitation procedures. The samples collected by Hessain *et al.* (2013) were from University farms bulk milk. The differences might be due to the lack of improper handling and hence contaminations by microorganisms as most of camel owners practice less hygiene during milking and storage of their milk (Sheiup *et al.*, 2007). The lack of the cooling facilities might be another cause of this high acidity. This lower acidity might be due also to the lower compositional content of camel milk, which suggesting the urgent need of structuring proper marketing channels for camel milk supported by cooling and pasteurization facilities as was recommended before by El Zubeir (2012).

Table 3: Compositional content of camel milk from various production systems in Sudan

Camel milk constituents	Butan (Eastern Gezira)	Eastern Nile	Eastern Nile	Western Omdurman	Eastern Nile	Camel Research Centre Farm
Production systems	Nomadic	Transhumance	Transhumance	Nomadic	Nomadic	Gracing +supplement
Total solids (%)	11.95±0.47	10.98± 0.53	9.56 ± 0.88	9.41 ± 0.93	9.22± 0.723	11.97±0.13
Lactose (%)	3.74±0.37	3.82± 0.315	3.12 ± 0.81	2.89 ± 0.62	-	4.63±0.05
Fat (%)	4.14±0.28	3.01± 0.086	2.64 ± 0.40	2.85 ± 0.48	2.83± 0.14	3.31±0.03
Protein (%)	3.22±0.21	3.19± 0.165	3.01 ± 0.45	2.94 ± 0.41	3.06±0.82	3.18[a]±0.03
Ash (%)	0.83±0.05[*]	0.82± 0.046	2.93 ± 0.29	0.73 ± 0.12	0.63±0.197	0.70±0.00
Acidity (%)			0.15 ± 0.02	0.14 ± 0.02	0.226±0.015	0.160±0.002
Authors	Nabag *et al.* (2006)	El-Amin *et al.* (2006)	Shuiep *et al.* (2008)	Shuiep *et al.* (2008)	El Zubeir and Hassan (2006)	Hessain *et al.* (2013)

5.Variation in the compositional content of camel milk

The data in Table 4 revealed non significant reduction in the solids not fat, fat, lactose, ash, non protein nitrogen content when applying both low temperature long time (LTLT) and high temperature short time (HTST) treatment. However the data showed that the total proteins, caseins and β-lactoglobulin were significantly ($P<0.05$)

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reduced after heating the camel milk. Moreover highly significant (P<0.01) reduction were observed for whey protein and albumin levels. Also the data in Table 4 suggested that low temperature long time is more suitable to preserve the constituents of camel milk. This goes inline with Gorakh and Pathak (2009) who found that when heating camel milk for 30 minuets, the whey proteins denaturated at higher temperature (90°C) compared to those heated at 63°C.

In order to preserve vitamin C of camel milk, LTLT is much better for its conservation (Table 4). This was in accord with Wernery *et al*. (2005) who reported that the most heat sensitive vitamin C was only affected by 5 to 8% reduction of the value found in raw milk when heated at 72^0C for 5 minutes. Bylund (1995) stated that when milk is pasteurized at 71^0 C, for 5 minutes the phosphatase enzyme is destroyed, however vitamin C is not affected. The overall reduction in vitamin C is not significantly (P>0.05) between raw and heat treated camel milk samples. Originally the content of vitamin C in camel milk samples revealed means of 50.50±11.35, 48.49±11.86, 47.08±11.38 and 45.41±11.08 mg/l for raw, LTLT, HTST (72°C) and HTST (78°C) camel milk, respectively (Hessain *et al.*, 2013). The content of vitamin C reported by Sawaya *et al*. (1984) ranged between 25 to 60 mg/l. Camel milk is known to be a rich source of vitamin C. it contains three (Farah *et al.*, 1992) to five times (Stahl *et al.*, 2006) higher than that in bovine milk. Wernery *et al.* (2005) reported that the reduction in vitamin C concentration following pasteurization of camel milk was minimal and this could be considered as tremendously advantageous for the consumer in arid and semi-arid countries where vitamin sources are scarce.

Table 4: The lever of reduction (%) in the chemical composition of raw camel after heat treatment

Parameters	LTLT (63°C, 30 minutes)	HTST (72°C, 15 seconds)	HTST (78°C, 15 seconds)	Significant level
Fat	0	0.302	0.302	NS
Solids not fat	0.999	0.998	0.997	NS
Lactose	0.432	0.432	0.648	NS
Ash	0	0	0	NS
Total proteins	0.314	1.572	1.887	*
Caseins	0	1.770	4.425	*
Whey proteins	0	11.111	22.222	**
Albumin	4.545	9.091	15.152	**
β-lactoglobulin	13.043	43.478	43.478	*
Non protein nitrogen	0	7.143	7.143	N.S
Vitamin C	3,02	5.84	9.18	N.S

*= p< 0.05
**= p<0.01
N.S= Non significant

6. Marketing of camel milk and products

The concept of selling camel milk is generally not accepted among nomadic camel herders in Darfur, Sudan (Musa *et al.*, 2006). Moreover El Zubeir and Nour (2006) reported that it is very difficult to evaluate the economic significance of camel milk production in Khartoum State because almost all milk produced is to satisfy the households and herders. However Shuiep *et al.* (2013) found that 48% of interviewed nomadic families in Kordofan were more flexible to accept the concept of marketing their products. On the other hand, 52% of interviewed nomadic families are against selling camel milk, which is in line with

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Musa *etal.* (2006). Moreover the camel herders adopting the semi intensive system are producing camel milk on commercial level (Shuiep and El Zubeir, 2012). The establishment of this new production system of course, has economical and social impact on the life of camel herders (Shuiep *et al.*, 2013).

The production of milk is the main reason for sustainability of semi intensive production system and contributed to food security of the herders as the earned money from selling milk; usually the price is 3 times higher compared to cow's milk; and male off-springs are for support the families in the home resident (Shuiep and El Zubeir, 2012). In the nomadic systems, the elderly women are responsible for processing and marketing of *gariss* and the earned money were used to satisfy some of the household Needs (Shuiep *et al.*, 2013). Commercialization of camel fermented milk are rare due to the lack of market orientation among camel keepers, poor hygienic practices, public health risks, unavailability of appropriate processing methods, inefficient transport, lack of standards and quality measures (El Zubeir, 2010).

Camel milk has high market demand in the country; nevertheless, lack of roads, the high ambient temperature, lack of cooling facilities and organized transportation systems are also among the constraints for camel milk marketing (Shuiep *et al.*, 2013). El Zubeir (2012) recommend to the governmental and private institutes to initiate the collection centers equipped with the technical facilities in order to enhance the processing and trade of the non utilized milk from camel and other species animals in Sudan. Wernery *et al.* (2003) reported that camel's milk is more heat resistant than cow's milk which is advantageous in commercial production of camel milk products. This is mainly because of the successful implementation of modern dairy factories of camel milk, which was already started in United Arab Emirate, Mauritania, Saudi Arabia and Kenya. Correra and Faye (2009) reported that pasteurized camel milk is produced for market in Nouakchott and for importation after the establishing of 2 modern dairy factories since 1989 and 1994. Moreover the reduction of the imported milk is reduced to half the quantity in 2000 compared to 1992.

Future prospective of camel milk processing and marketing

The result of the importance of heat treatment of camel milk and increasing marketing attitudes are part of the intervention done to improve the camel herders. The officials' governmental organizations, researchers, camel communities' leaders and the private sectors are also attending the main workshop and the seminar. The outcomes of the workshop and field visits are promising and suggesting that more effort and interventions to be carried out in others places and different camel herding societies. Also the lessons learned as well as new ideas of processing camel milk products with acceptable quality from Sudan and else where are to be implemented in the other states of the country and regions for suitability of camel herding communities/ However the prevalence of diseases, feeding cost, fluctuation of milk price, the low fertility of the herds, extension and training services, proper veterinary supervision are urgently needed. Moreover establishment of proper collection equipped with cooling and transport facilities and processing units will provide a good opportunity for national and international trade of camel milk, provided that regulatory standards are to be adopted.

It is concluded that heat treatment would improve camel milk quality and extended its shelf life, hence it is high time for Sudan to establish camel milk processing for national and international trade.

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تصنيع اللبن السائل و تسويقه للتنميه المستدامه في مجتمعات مربي الابل

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المستخلص:

لبن الابل له دور مهم في تغذية الرحل لانه يحتوي علي كل المغذيات الأساسية التي توجد في لبن الأبقار. بالرغم من ان معظم البان الابل المنتجة يتم استهلاكها محليا لأنها لا تصل الي أسواق الحضر بسبب عدة معوقات. حاليا تتواید الطلب علي البان الابل في اوساط سكان الحضر وذلك بسبب زيادة الوعي عن قيمته العلاجية. تم كشف بعض مسببات الفساد والامراض في عينات لبن الابل الخام بالرغم من ان للبن الابل فترة صلاحية أطول مقارنة بلبن الأبقار. طول فترة الصلاحية هذه يمكن تمديدها عند اجراء المعاملة الحرارية والتي تفتقد في أوساط أغلب مجتمعات الرحل. قد وجد ان اضافة انزيم نظام اللاكتوبيروكسيد و بعض النباتات العشبية تحسن من جودة حفظ لبن الابل. طرق الحفظ الصحية تلك تحسن الحمولة الميكروبية وت زيد فترة صلاحية لبن الابل بتاثير سلبي بسيط علي محتوي مكوناته متضمنة فيتامين ج. لذا يمكن تسويق لبن الابل من المناطق البعيدة للمستهلكين الحضر للتجارة والعالمية. بالرغم من ان هذا يستوجب ضرورة انشاء مراكز لتجميع اللبن ووحدات لتصنيعه مزودة بتسهيلات ولفت انتباه مجتمعات مربي الابل لقبول تسويق البانهم و التي ستؤدي الي تحسين نمط مستوي معيشتهم. بعض خطط و سياسات الحكومة يجب ان توجه نحو دعم التسهيلات والخدمات ووضع المواصفات المنظمة حتي يتثني مؤاكبة مقاييس جودة اللبن العالمية.

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