IBTISAM E.M. EL ZUBEIR

Extending the Shelf Life of Camel Milk

This article is based on a study carried out to increase the efficiency of the keeping quality of raw milk by the activation of the lactoperoxidase enzymes system (LPS), which was recommended by FAO. Fresh raw milk samples from both bovine and dromedary milk were obtained from the University of Khartoum farm during May 2010. The activation was done two hours later after the morning milking and the milk samples were divided into LPS-activated and control samples. The preservation of the samples was then carried out at room temperature (37° C) and refrigeration conditions (8° C). All samples were subjected to some quality tests (standard plate count, acidity and clot–on-boiling test) during the storage period.

The LPS-treated milk samples from camels showed better keeping quality and longer shelf life than cow's milk both at room temperature (10 vs. 3 days) and refrigerator temperature (14 vs. 9 days), compared to non-treated milk samples stored at room temperature (3 days and 6 hours) and refrigerator temperature (10 and 3 days), respectively.

The data obtained are compare favorably with the control samples stored in refrigeration conditions. This supported the previous recommendation that LPS is an efficient method for preservation and prolonging the shelf life of raw milk in tropical environments that lack refrigeration facilities. 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. It is also recommended that the governmental and private institutes should establish the collection centers equipped with technical facilities to enhance the processing and trading of the non-utilized milk from camels and other species in Sudan.

INTRODUCTION: THE VALUE AND SUPREMACY OF CAMEL MILK

More than 60% of the dromedary population is concentrated in the four northeast African countries of Somalia, Sudan, Kenya and Ethiopia. Somalia with over six million head has the largest herd in the world, followed by Sudan with more than four million (Farah et al. 2007). Dromedaries are natural browsers and thrive and produce milk on rough, sparse pasture, where other domesticated animals would virtually starve (Elamin 1984). This makes the lactating she-camel a very valuable animal for the nutrition of the camel herder's family in this harsh environment. Camels, besides many other functions in nomadic life, are reliable milk producers with a long lactation period, and they maintain milk production throughout the long dry spell when milk from other livestock is scarce (Bekele et al. 2002).

Farah (1996) reported that camel milk is a very important human nutrient in several zones of tropical and subtropical regions, where it represents the only protein source. Camel's milk is used in some parts of the world as a cure for certain diseases and is a rich source of proteins with potential antimicrobial and protective activities; these proteins are not found in cow's milk or only in minor quantities (Wernery 2003). Proteins and peptides such as lactoperoxidase, lactoferrin, bacteriocins, lysosome and xanthine oxidase occur naturally in milk and have antimicrobial properties (Yuan 2001).

Hussain/Islam (1990) stated that the majority of the dairy farmers in many countries cannot install cold rooms or buy refrigerators. Similarly, heated milk is not generally accepted by the public. An alternative method is to preserve milk with chemical preservatives. However, the FAO/WHO strongly discourage this except by the use of hydrogen peroxide (H_2O_2) at native

LPS (Ozer et al. 2003). If H_2O_2 is added to the milk samples, heat treatment should be applied before use in order to ensure the complete destruction of the residual H_2O_2 (to water and oxygen) before consumption. On the other hand, Hannuksela et al. (1994) mentioned that the lactoperoxidase is a natural bacterial defense system through the oxidation of thiocynate ions (SCN-) by hydrogen peroxide. These are both present in biological fluids and together with lactoperoxidase are termed the lactoproxidase enzyme system (LPS). This is based on the activation of the lactoproxidase, thiocyanate and hydrogen peroxide system (naturally present in milk in varying concentrations) to inactivate several vital metabolic bacterial enzymes, consequently blocking their metabolism and ability to multiply (Gaya et al. 1991).

Compared to cooling in small-scale dairy enterprises, coupled with good hygiene and sanitations the lactoproxidase system is a reliable and economical method of preserving raw milk (FAO/WHO, 2005). This natural antimicrobial system present in milk has been used to preserve raw milk quality in areas where for technical and/or economic reasons it is not possible to use mechanical refrigeration (Seifu et al. 2005). Its application at collection centers is aimed at raising regional awareness of a safe, cheap and effective alternative milk-preservation method (Codex Alimentarius Commission 2004).

The raw milk sold to consumers in Sudan is never subject to the real quality-control measures needed for good quality food (Mohamed/El Zubeir 2007). The country's dairy industry is weak and at an early stage of development, since the marketing of raw milk and dairy products made from raw milk are common features of dairy marketing in Sudan (Elmagli/El Zubeir 2006b). However, currently some new private dairy factories have begun processing dairy products, but they have faced many problems, of which the quality control measures constitute an important concern (Abd Elrahman et al. 2009). Moreover, the lack of a stable electricity supply is one of the main constraints facing dairy-product marketing. Most use raw milk supplied without cooling, as the milk-marketing system is weak and at a transitional stage (Elmagli/El Zubeir 2006a). These situations necessitate the introduction of safe methods of preservation suited to local conditions. The recent awareness of the medicinal value of camel milk is leading to more commercially oriented attitudes by the *abbala* (camel herders) in Sudan, towards selling camel milk, which was previously given free of charge or as a gift (Sheiup/El Zubeir 2008). Camels represent the backbone in the economic life of the *abbala*, either by selling male camels in local markets or for export (Musa et al. 2006). Some camel herders have started to sell their raw milk in urban and suburban areas (Sheiup/El Zubeir 2008). The introduction of LPS makes it possible to preserve camel milk for commercialization, as camels are always far from the consumers, in search of water and pasture. This study was thus carried out as a trial to evaluate the preservation of milk using lactoperoxidase enzyme system, new enzyme kits that have been recently approved and introduced to the developing countries by the FAO for further demonstration after the successful large-scale field trials in Pakistan, the Philippines and Cuba, which have shown promising results (Lambert 1993). Currently the kits are distributed free by FAO for field trials involving 80 developing countries, one of which is Sudan.

MATERIALS AND METHODS: CAMEL MILK IN COMPARISON WITH COW'S MILK

The lactoperoxidase enzymes system for the preservation of camel's and cow's milk in this study was obtained from Ministry of Animal Resources. The kits were offered by the FAO for field trials of the LPS in Sudan. The study was carried out in May 2010. Camel's milk and cow's milk samples were obtained from the University of Khartoum farm and were examined after two hours of milking.

The samples were divided into two equal portions; treated (by the addition of LPS) and control. Both treated and control samples were put into 20 ml sterile bottles and kept both at room temperature (37 °C) and refrigerator temperature (8 °C). The samples of the two types of milk were divided into eight groups: control camel-milk samples kept at room temperature (CR), control milk samples kept at refrigerator temperature (CC), treated milk samples kept at room temperature (TR) and treated milk samples kept at refrigerator temperature (TC).

ANALYSIS OF MILK SAMPLES

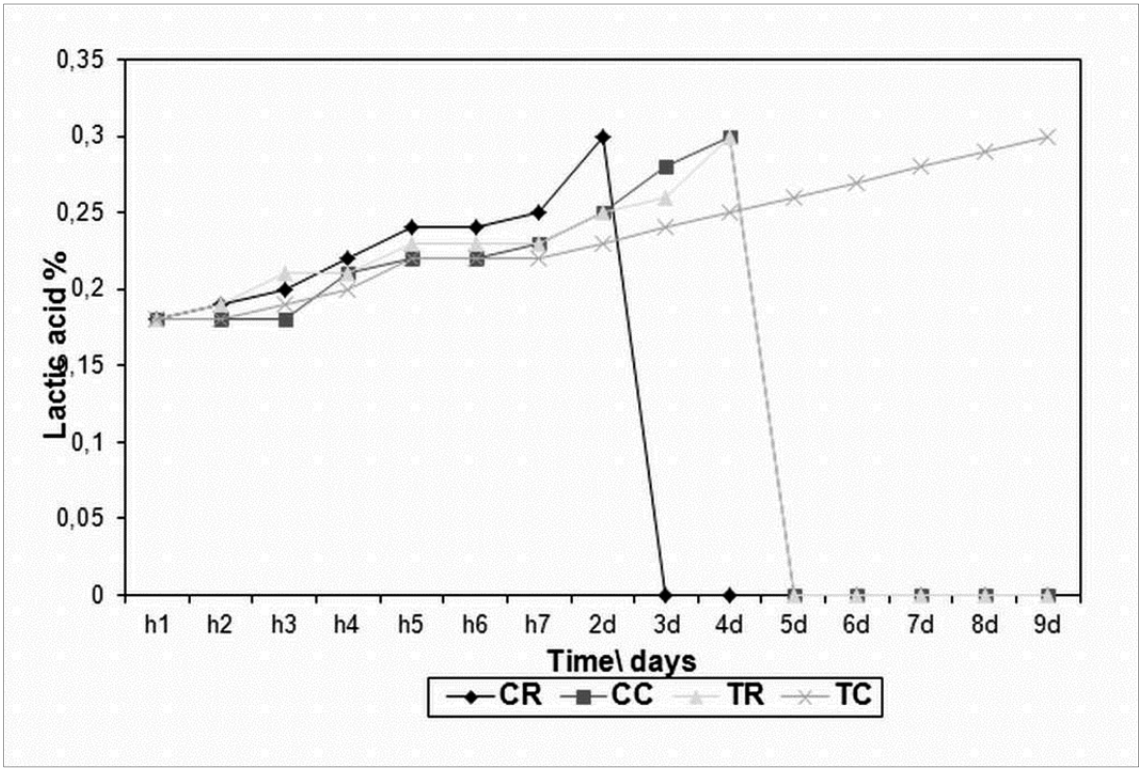
The acidity of the milk samples and the clot-on-boiling test were carried out according to Foley et al. (1974). Both acidity and the clot-on-boiling test were determined daily to assess the shelf life. Plate-count agar was used to determine the total viable bacterial counts. Preparation of the samples, serial dilutions of milk samples, the incubation (32º C for 24–48 hours) and counting were done according to Houghtby et al. (1992).

Measurements		**Camel's milk**	**Cow's milk**
Treated by LPS	Refrigeration	14 days	9 days
	Room	10 days	3 days
Control	Refrigeration	10 days	3 days
	Room	2 days	6 hours

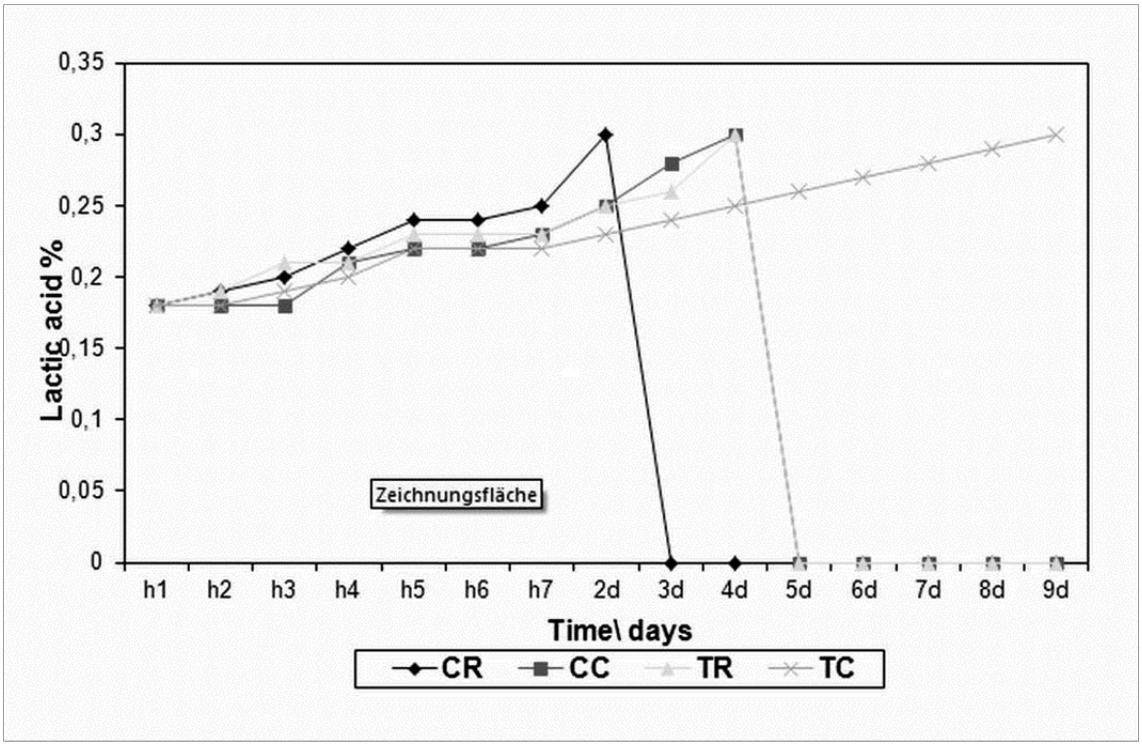
Table 15: The effect of lactoperoxidase enzyme system on the keeping quality (shelf life/day) of the camel's and cow's milk.

RESULTS AND DISCUSSION

The study showed that the addition of lactoperoxidase enzymes system resulted in improved keeping quality and shelf life of both camel's and cow's milk whether at room or refrigerator temperature (see table 15). The treated milk samples kept at room temperature had a longer shelf life than the control samples. Moreover, and as detected by the acidity, the addition of lactoperoxidase enzymes system to camel's milk (see graph 32) was more efficient compared to cow's milk (see graph 33).



Graph 32: Variation in the development of acidity in camel's milk treated by lactoperoxidase enzymes system. In this and the following figure: CR= control milk kept at room temperature; CC= control milk kept at refrigerator temperature; TR= treated milk kept at room temperature; TC= treated milk kept at refrigerator temperature.



Graph 33: Variation in the development of acidity in cow's milk treated by lactoperoxidase enzymes system.

This suggested that the lactoperoxidase enzymes system can be used as an efficient procedure for keeping the milk in farms and areas where there are no cooling facilities (Lambert 1993). This was in accord with El Zubeir et al. (2006). Hence it might help in marketing camel milk in towns where it can have commercial values especially because of its health and nutritional benefits (Wernery 2003).

The results show that the LPS-treated milk samples kept at room temperature did not show any significant difference in total viable bacterial counts when compared to the samples kept in the refrigerator. This might be because two hours' exposure of combined LPS resulted in a decrease in numbers of viable bacterial attached to the stainless steel (Dufour et al. 2004). It might also indicate that LPS could be a method of milk preservation when cooling facilities are not available (Lambert 1993, Seifu et al. 2005, El Zubeir/Hassan 2006). The suppression of bacteria by LPS indicated the antimicrobial effect of LPS (McLay et al. 2002, Dufour et al. 2004)

CONCLUSIONS AND RECOMMENDATIONS

The study recommended the uses of LPS in Sudan after establishment and development of milk collection centers, especially in the rural areas in order to utilize the large quantities of milk that has been unavailable to the consumers. Further research on the antimicrobial effect on the different milk-borne diseases and spoilage organisms is needed to examine the LPS under the different conditions of Sudan.

REFERENCES

Abd Elrahman, S M A/Said Ahmed, AMM/El Zubeir, Ibtisam, EM/El Owni, OAO/Ahmed, MKA (2009): "Microbiological and Physicochemical Properties of Raw Milk used for Processing Pasteurized Milk in Blue Nile Dairy Company (Sudan)", in: *Australian Journal of Basic and Applied Sciences* 3/4, pp. 3433–3437

Bekele, T/Zeleke, M/Baars, RMT (2002): "Milk Production Performance of One Humped Camel (*Camelus dromedarius*) under Pastoral Management in Semi-arid Eastern Ethiopia", in: *Livestock Production Science* 76, pp. 37–44

Codex Alimentarius Commission (2004): The Report of the Codex Committee on Food Hygiene (CCFH). *Twenty-seventh Session of the Codex. Alimentarius Commission*. FAO/WHO Food Standards Programme, Geneva

Dufour, M/Simmonds, RS/Bremer, PJ (2004): "Development of a Laboratory Scale Clean-in-place System to Test the Effectiveness of 'Natural' Antimicrobials Against Dairy Biofilms", in: *Journal of Food Protection* 67/7, pp. 1438–1443

Elamin, FM (1984): "The Dromedary of the Sudan", in: Cockrill, Ross W. (ed.): *The Camelid: An All-purpose Animal. Proceedings of the Khartoum Workshop on Camels, December 1979*. Uppsala: Scandinavian Institute for African Studies

El Zubeir, IEM/Hassan, AK (2006): "Improvement of the Shelf Life of Camel Milk Using Lactoperoxidase Enzyme System", *The 4th Conference on Scientific Research Outlook and Technology Development in the Arab World,* Damascus

---/El Hassan, MEM/Yagoub, SO (2006): "Preservation of Raw Milk of Khartoum State (Sudan) by the Lactoperoxidase Systems", in: *International Journal of Dairy Science* 1/2, pp. 155–160

Elmagli, AAO/El Zubeir, IEM (2006a): "Study on the Compositional Quality of Pasteurized Milk in Khartoum State (Sudan)", in: *International Journal of Dairy Science* 1/1, pp. 12–20

---/El Zubeir, IEM (2006b): "Study on the Hygienic Quality of Pasteurized Milk in Khartoum State (Sudan)", in: *Research Journal of Animal and Veterinary Sciences* 1/1, pp. 12–17

FAO/WHO (2005): "Benefits and Potential Risks of the Lactoperoxidase Systems of Raw Milk Preservation: Technical Meeting 28 November – 2 December 2005", FAO Headquarters, Rome, Italy

Farah, Z (1996): *Camel Milk Properties and Products,* SKAT, Swiss Centre for Developments Cooperation in Technology and Management

---/Mollet, M/Younan, M/Dahir, R (2007): "Camel Dairy in Somalia: Limiting Factors and Development Potential", in: *Livestock Science* 110, pp. 187–191

Foley, J/Buckley, J/Murphy, MF (1974): *Commercial Testing and Product Control in the Dairy Industry*. Cork: University College

Gaya, P/Medina, M/Nunez, M (1991): "Effect of the Lactoperoxidase System on *Listeria monocytogenes* Behavior in Raw Milk at Refrigeration Temperatures", in: *Applied Environmental Microbiology* 57/11, pp. 3355–3360

Hannuksela, S/Tenovuo, J/Roger, V/Lenander-Lumikari, M/Ekstrand, J (1994): ''Floride Inhibits Theantimicrobial Peroxidase Systems in Human Whole Saliva'', in: *Caries Research* 28/6, pp. 429–434

Hussain, MS/Islam, MN (1990): "Studies on the Preservation of Milk with Hydrogen Peroxide", in: *Bangladesh Journal of Animal Science* 8, pp. 51–54

Houghtby, GA/Matu, LG/Koeng, EK (1992): "Microbiological Counts Methods", in: *Standard Methods for the Examination of Dairy Products* (16th edition). Washington, DC: APHA, pp. 215–217

Lambert, JC (1993): "The Lactoperoxidase System Experiences from Cuba, the Philippines and Pakistan", in: *Seminar Proceedings: Dairy development policy and implementation: Sharing experience between Africa and Asia*. Harare, pp. 262–268

McLay, JC/Kennedy, MJ/O'Rourke, AL/Elliot, RM/Simmonds, RS (2002): "Inhibition of Bacterial Foodborne Pathogens by the Lactoperoxidase System in Combination with Monolaurin", in: *International Journal of Food Microbiology* 73/1, pp. 1–9

Mohamed, NN I/El Zubeir, IEM (2007): "Evaluation of the Hygienic Quality of Market Milk of Khartoum State (Sudan)", in: *International Journal of Dairy Sciences* 2/1, pp. 33–41

Musa, H H/Shuiep, ES/El Zubeir, IEM (2006): "Camel Husbandry Among Pastoralists in Darfur, Western Sudan", in: *Nomadic People* 10/1, pp. 101–105

Ozer, B/Grandison, A/Robinson, R/Atamer, M (2003): "Effects of Lactoperoxidase Hydrogen Peroxide on Rheological Properties of Yoghurt", in: *Journal of Dairy Research* 70/2, pp. 227–232

Seifu, E/Buys, EM/Donkin, EF (2005): "Significance of the Lactoperoxidase System in the Dairy Industry and its Potential Applications: A Review", in: *Trends in Food Science and Technology* 16/4, pp. 137–154

Sheiup ES/El Zubeir IEM (2008): "Current Practices and Future Prospective in Pre-urban Camel Farming in Khartoum State, Sudan": *Tropentag Conference: Competition for Resources in a Changing World: New Drive for Rural Development.* 7–9 October 2008, Hohenheim, Germany

Wernery, U (2003): "Novel Observations on Camel Milk", in: Camel Health in Relation to Camel Milk. Proceeding of the 9th Kenya Camel Forum

Yuan, J (2001): "MAP for Shelf-life Extension and its Synergy with Ozone": *Extended Shelf Life of Foods: Quality and Safety Symposium*, 7. Oak Brook, Il., US