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Simple Cooling Method Improves the Quality of Marketed Camel Milk in Northern Kenya

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Milk marketing is important for many pastoralists to generate income, especially poor households with little else to sell. Milk is accumulated at pastoral settlements and transported to local markets on foot, by pack animals, or in vehicles. Despite challenges of heat and long-distance travel, pastoralists or traders do not attempt to cool marketed milk and possibly reduce risk of spoilage. Milk spoilage is an important problem that limits urban consumer demand. Our research objective was to determine effects of water-soaked hemp (burlap), wrapped around plastic jerry cans, on reducing milk temperature and enhancing quality of marketed camel milk, a key commodity in northern Kenya. The study employed an experimental design using pairs of 3-liter jerry cans, with or without water-soaked hemp, transported by donkey and lorry on eight market runs between Kulamawe and Isiolo. Samples of milk taken at morning milkings and mid-afternoon after market arrival were analyzed for temperature and standard milk-quality parameters. Milk took 7.4 hours to travel 80 km to market. Hemp treatment significantly reduced average milk temperatures by 13% and total bacterial counts by 44%. This simple and readily adoptable intervention can therefore reduce risks of milk spoilage along this value chain under similar field conditions.

Background

Livestock production remains the economic mainstay of most pastoralists living in Isiolo District. Livestock and livestock products, notably camel milk, significantly contribute to household food and income needs, especially among poorer households. Milk intended for sale is often collected among neighboring households at pastoral settlements and mixed in plastic jerry cans. The jerry cans are then transported by people, pack animals, or vehicles to market. Transport constraints, in particular, are a big challenge for milk marketing in this region since most roads are in poor condition, vehicle traffic may be infrequent, and there is no opportunity for refrigeration. As a result, marketed milk is typically exposed to high temperatures for prolonged periods of time, increasing the risk of spoilage and imposing marketing constraints. Urban consumers in the region are often unsatisfied with locally produced milk because of the poor quality and danger to human health (Wayua et al., 2007). Some consumer groups in Moyale, Kenya, have indicated a willingness to pay at least 20% more for milk of a higher quality than what is typically found in their marketplace (Wayua et al., 2008; 2009).

Primary requirements for adequate preservation of dairy products include storing them under cool temperatures, using hygienic handling methods, and offering protection from oxygen and bacteriological contamination. Extensive work on bovine milk marketing and hygienic handling in high-potential areas of Kenya has been reported, but little attention has been given to camel milk in the lower-potential areas of northern Kenya. The objective of this study was to determine whether water-soaked hemp (burlap) wrapped around jerry cans, could help prolong the shelf life and enhance the quality of marketed camel milk. Long-distance lorry drivers in this region often use water-soaked, fabric containers to keep their drinking water cold via evaporative cooling and convection; such containers are suspended on the outside of moving vehicles. We wondered if the same simple principle could be applied to the local transport of milk.

Research was conducted in the Kulamawe milk catchment of Isiolo District. The catchment is occupied by pastoral encampments or *manyattas*. A settlement also called Kulamawe serves as a central milk collection point for the catchment. The catchment supplies milk to the residents of Isiolo town, and supply greatly varies by season. The cooler wet season is a time of greater forage and water resources for livestock, and hence a higher marketed milk supply, while the warmer dry season is the reverse. Milk is first transported by donkey from the *manyattas* to the Kulamawe settlement (Figure 1). The milk is then loaded on a lorry that travels from Kulamawe to the Isiolo market. In times of high marketed supply, milk may also travel onwards from Isiolo to Nairobi by bus.

Methods

The design employed paired 3-liter plastic jerry cans, with and without water-soaked hemp (Figure 2), on a series of eight milk runs using donkey and lorry transport methods as above. The overall distance to market from the pastoral

Figure 1. Milk being transported by donkey to the collection point at Kulamawe. Photo by H.K. Walaga.

manyatttas averaged about 80 kilometers (km), with 10 km of this distance traversed by the donkeys and the remainder by lorry. There were two sets of four containers used on any given market day. All eight containers received the same well-mixed milk from the *manyattas*. Four of the eight containers were wrapped in water-soaked hemp, while four served as the control group. The hemp-wrapped containers were soaked only once at the start of the milk transport process. All containers were otherwise identical and representative of what the people actually use to store and transport milk. Care was taken to load the paired containers in a complementary fashion on the donkey packs or in the back of the vehicle, while considering a balanced and equivalent exposure of the containers to either direct sunlight or wind associated with driving. Half of the containers were therefore categorized as either "less exposed" or "more exposed" to wind, depending on their placement.

Milk samples were taken from each container just after collection and again after the milk arrived at the Isiolo market. Milk temperatures were also taken at these times. Ambient air temperatures were taken at several times during the transportation process, as were observations of hemp moistness. There were 16 milk samples for each of eight milk runs for a total of 148 samples. Milk runs were conducted in the warm dry season, as this was thought to be the period when the hemp intervention could be most useful. Milk samples were put on ice immediately after collection and transported to a local laboratory where they were frozen until chemical analyses could be performed. These analyses included standard determinations for milk composition and quality. Statistical analyses that are shown here used ANOVA with mean separation tests from SAS. Technical details and data can be obtained from the authors.

Findings

Generally, the camels were milked between 06:00 to 08:30 AM each morning at the *manyattas*. After collection and mixing, the milk then traveled 1.5 hours by donkey to the Kulamawe settlement. The lorry would leave the Kulamawe settlement around 11:00 AM each day and arrive at the Isiolo town market by 2:30 PM. The average time between milking and market arrival was thus about 7.4 hours. The average (±SE) ambient air temperatures were 24 ±0.3 °C in the early morning at the *manyattas*, 28± 0.3 °C at the Kulamawe settlement, 29±0.3 °C at a midway transit point (about 35 km) between Kulamawe and Isiolo, and 26±0.4 °C at the Isiolo market by mid-afternoon.

Milk temperatures are summarized in Table 1. The temperature of the control (untreated) milk did not significantly vary between the morning collection time and the market arrival time. The temperature of the treated milk (using the water-soaked hemp containers) did significantly change over the same time frame, however, with a net temperature reduction of 14%. The treated milk was also cooler than the control milk at the time of market arrival, with a net reduction of about 13%. Table 1 also shows results for total bacterial counts (TBC) of milk. The TBC values of milk destined for treatment or controls were similar at the time of milk collection, but by the time the milk arrived at the Isiolo market, concentrations had increased 4.5-fold for the control milk and 3.1-fold for the treated milk. This reduction in TBC was 44% and statistically significant. Bacterial counts for milk in this study were always high in comparison with accepted dairy standards for Kenya. This indicates that general hygiene related to milk handling at the *manyattas* is poor.

Table 1. Average temperatures (°C ± standard errors) and average total bacterial counts (TBC) per milliliter (TBCs x 10^5 ± standard errors) for camel milk collected in the morning at manyattas *in Kulamawe and after transport to the Isiolo marketplace by mid-afternoon.*

Milk	***Manyatta* (early morning)**		**Isiolo Market (mid afternoon)**	
	Temperature	**TBC**	**Temperature**	**TBC**
Control (traditionally transported in jerry cans)	28±0.7	60±12.6	28±0.8*	266±26.9*
Treated (transported in jerry cans wrapped with water-soaked hemp)	28±0.8	47±12.6	24±0.5*	149±26.9*

Each number is the average temperature of 37 milk samples. Asterisk (*) indicates statistical significance between values within the same columns (P≤0.05).

Other chemical tests measuring milk acidity and bacteriological quality were undertaken. The data (not illustrated here) demonstrate that control milk had accelerated acidification, souring, and bacteriological growth compared to treated milk. Results also indicated that placement of hemp-wrapped containers with respect to wind exposure is significant in mediating milk-temperature responses. The "more-exposed" containers tended to dry out after only three hours of transport, while the "less-exposed" containers stayed moist until arrival at the Isiolo market. The "less-exposed" containers would therefore tend to maintain cooler temperatures and milk quality for a longer period of time.

Practical Implications

Based on all parameters for measuring milk quality and hygiene, this study has confirmed that simple milk-cooling techniques such as wrapping jerry cans in water-soaked hemp can significantly reduce milk temperature as well as reduce the risk of milk spoilage for this particular value chain, under these ambient conditions. Overall, we have demonstrated that this soaked-hemp treatment reduced milk temperature by 13% and TBC by 44%. We recommend that local extension agents, producers, and traders conduct their own tests of this simple methodology. Hemp is readily available and inexpensive, and the water required for a one-time soaking is minimal. The ultimate test of the usefulness of the practice will be determined if and when consumers respond by recognizing the improvement in milk quality and then paying a premium for a more desirable product.

Figure 2. Close-up of hemp-wrapped and control milk containers in a lorry destined for the Isiolo market. Photo by A.O. Adongo.

Further Reading

Wayua, F.O., M. Shibia, and S. Mamo. 2007. "Consumer Perceptions on the Quality and Marketing of Milk in Moyale, Kenya." *Research Brief 07-07-PARIMA.* Global Livestock Collaborative Research Support Program (GL-CRSP), University of California – Davis, Davis, CA.

Wayua, F.O., M. Shibia, S. Mamo, D. Bailey, and D.L. Coppock. 2008. "What are Consumers in Moyale, Kenya Willing to Pay for Improved Milk Quality?" *Research Brief 08-01 PARIMA.* Global Livestock Collaborative Research Support Program (GL-CRSP), University of California – Davis, Davis, CA.

Wayua, F.O., M. Shibia, S. Mamo, D. Bailey, and D.L. Coppock. 2009. "Willingness to pay for improved milk sensory characteristics and assurances in northern Kenya using experimental auctions." *International Food and Agribusiness Management Review* (IAMA) 12(3): 69-88.

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The GL-CRSP Pastoral Risk Management Project (PARIMA) was established in 1997 and conducts research, training, and outreach in an effort to improve the welfare of pastoral and agro-pastoral people with a focus on northern Kenya and southern Ethiopia. The project is led by Dr. D. Layne Coppock, Utah State University. Email: Layne.Coppock@usu.edu.

The Global Livestock CRSP is comprised of multidisciplinary, collaborative projects focused on human nutrition, economic growth, environment and policy related to animal agriculture and linked by a global theme of risk in a changing environment. The program is active in East and West Africa, and Central Asia.

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