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Full Length Research Paper

Utilization of high acid milk at Rural and Peri-Urban milk value chain systems in Nakuru County, Kenya

Faith Ngundi Ndungi[1*], Patrick Muliro[1], Abdul Faraj[1] and Joseph Matofari[1]

[1]Department of Dairy, Food Science and Technology, Egerton University, P. O. Box 536-20115 Egerton, Kenya.
Corresponding author's Email: faith.ndungi@gmail.com

Abstract

Developed acidity in milk, a major proportion of post-harvest losses in smallholder delivered milk at collection centers, results from microbial activity as it is being transported or stored under uncontrolled temperature. The resulting high acid milk is considered of low quality and rejected based on failed alcohol test. The contribution of rejected milk to post-harvest losses is documented however its utilization is not. This study therefore determined this milk's utilization. Using a semi-structured researcher administered questionnaire, Focus Group Discussions, observation checklist and Key Informant Interviews, data was collected.Results reveal insufficiency of milk quality control at the collection centers. Several volumes of milk failed quality control tests per month resulting to milk post-harvest losses. Frequency of milk rejection was higher during rainy season compared to the dry. Naturally fermented milk was the most common product developed from rejected high acid milk. Other farmers mentioned the disposal of this milk while others fed it to animals and/or sold it to neighbours. The study concludes that once safety and physico-chemical quality of high acid milk is determined, appropriate technologies for processing can be used to develop milk products.

Key words: Milk post-harvest losses, High acid milk, Milk collection centers

INTRODUCTION

More than 80% of the total milk produced in Kenya is handled by processors. Farmers' organizations such as cooperative societies and farmers' groups handle only about 40% of marketed milk production and about 20% of total milk (Muriuki, 2003).These organizations are formed to enable farmers market their milk more efficiently by pooling their resources and the quantities of milk each of them produces (Kurwijila, 2006). This results in the collection and bulking of milk.

Farmer groups and operators of milk collection centers have systems of quality control for the milk they receive from individual farmers, therefore segregating poor quality milk. Simple platform tests are carried out to enable the centers ensure that only good quality milk is accepted for onward transportation to milk processing factories, milk bars or retailers of raw milk in urban centers. These centers therefore play an important role between the dairy farms and the dairy industry in terms of supplying high-quality, safe and adequate raw milk (Demirbas et al., 2009).

The tests that are carried out include: organoleptic test, alcohol test, and lactometer test. Milk that fails any of these tests is rejected. The alcohol test, which is the most common quality control test carried out, analyses milk on the basis of stability of milk casein micelles. Development of acidity in milk causes disintegration of these micelles(FAO, 2011).

Acid development in milk results from microbial activity as it is being transported from farms or stored under uncontrolled temperature. The long hours taken for milk transportation under uncontrolled temperatures provides favourable environment for microorganisms in milk, principally the lactic acid bacteria to ferment the milk. These microorganisms sour the milk by converting the milk sugar, lactose to lactic acid (IDF, 1992 a, b). At low levels of pH, casein is destabilized due to acid generated from fermentation (Walstra et al., 1999). The destabilization of casein is detected upon subjecting milk to the alcohol test. The milk is rejected upon failing the test.

Milk rejection contributes to post-harvest losses at farm level which can be more than 6% of total production (Muriuki, 2003). The contribution of rejected milk to post-harvest losses is documented however its utilization is not. This study therefore determined the utilization of coagulated or high acid milk that is rejected at collection centers. It sought knowledge on any products developed from this kind of milk as well as the products' processing steps.

MATERIALS AND METHODS

Study area

The study was conducted in Dundori (peri-urban area) and Olenguruone (rural area) Divisions found within Nakuru County in the Rift Valley region, Kenya.

Study design

The study regions were selected purposively based on the two dairy farming systems, that is, peri-urban and rural systems. Milk collection centers were then selected purposively based on the study region. Three collection centers were picked, two in Olenguruone and one in Dundori. These included: Wanyororo dairy cooperative society collection center in Dundori and Olenguruone Dairy Cooperative Society collection centers, Olenguruone and Kaplamai branches. Information on utilization and processing of high acid milk at household level at the two dairy farming systems was then collected. This information was obtained from collection centers, farmers and extension officers. Individuals in the collection centers provided information on quality control tests performed at the centers, amount of milk that fails either of the tests performed, frequency of milk rejection and the farmers whose milk fail the tests. Since the study sought interventions for high acid milk, only farmers whose milk failed the alcohol test were followed up. These farmers formed the sample size of those who responded to questions in the structured questionnaire. Any current products developed from the high acid milk, their processing methods and equipment used were documented.

Methods of data collection

Both quantitative and qualitative data collection approaches were used. The quantitative data was collected using semi-structured researcher administered questionnaire while qualitative data was obtained from Focus Group Discussions, observation checklist and Key Informant Interviews conducted among milk collection center staff, extension officers and women/small-scale dairy farmers who produced milk products. The qualitative information/ data complemented that from the structured questionnaire.

Semi-Structured Researcher Administered Questionnaire

Questions in the questionnaire addressed: milk production by the farmer in terms of amount, quality control tests performed on the milk, how the produced milk is used and quantities for each use, forms in which milk is consumed in the household, preferred form of consumption and reason for preference, sources of any milk products consumed, processing of milk products including the procedures and steps, cases of milk rejection and utilization of the milk and effects of dry and wet seasons on milk production, quality, milk rejection and dairy products development or milk processing.

Focus Group Discussions (FGDs)

Two focus group discussions were held with the farmers, to explore milk production, collection and bulking and quality control of the milk. The questions discussed included: How long does it take for the milk to reach the collection center? Which quality tests are performed on the milk? How much milk fails either of the tests? How frequent does milk fail the tests? and When rejected, explain how the milk is utilized? The discussions were recorded using a tape recorder.

Key Informant Interviews (KIIs)

The key informants were 2 extension workers from the two study regions and the milk collection centers managers. Questions asked included: Are you aware of any milk processing from rejected high acid milk by farmers? Which products are made from this kind of milk? Who prepares the mentioned products? How are the mentioned products made? What are the safety and quality measures regarding these products? and Do you offer the safety and quality training to the persons who prepare the products?

Observation Checklist

The checklist consisted of a list of areas/ topics of observation like: quality control tests performed at the

Figure 1 Study areas (made using ObservatoireSatellitaire des Foretsd'Afrique Centrale (OSFAC), 2014)

Table 1. Collection and bulking of milk in Dundori and Olenguruone

Name of collection center	Study region	Volume of milk collected	Source of milk collected (persons delivering)	Time taken by transporters (motorbike operators picking milk from different farmers) to reach center
Wanyororo Dairy Cooperative Society	Dundori	800liters/day	Farmers, transporters	3-4 hours
Olenguruone Dairy Cooperative Society (Olenguruone)	Olenguruone	8000liters/day	Farmers, transporters	3-5 hours
Olenguruone Dairy Cooperative Society (Kaplamai)	Olenguruone	1100liters/day	Farmers, transporters	3-5 hours

collection centers, milk rejection, utilization of the rejected milk and any processing methods and steps done on the rejected high acid milk.

Statistical Analyses

Data was analyzed using the Statistical Package of Social Sciences computer software version 19.0. Appropriate descriptive analysis were done. The focus group discussions and key informant interviews were transcribed and coded therefore converting most of the qualitative descriptions into quantitative data. Frequency distributions were then generated based on the quantitative data.

RESULTS

Collection and bulking of raw milk

Collection and bulking of raw milk depends on many factors including: the processors, intermediaries (traders),

Figure 2. Filling alcohol gun with alcohol

Figure 3. Scooping milk to be tested

Figure 4. No coagulation observed

Figure 5. Coagulation observed

Figures 2, 3, 4 and 5 show a demonstration and the mechanism of the alcohol test. Development of acidity in milk causes disintegration of the casein micelles. With the acid levels high enough, addition of an equal amount of 68% alcohol to milk leads to dehydration and further destabilization of casein which causes the milk to clot (coagulate). The alcohol gun is commonly used at the collection centers to perform the alcohol test

the road network and milk sheds. Collection and bulking in the two study areas depended mainly on intermediaries (traders) and the road network. Some farmers reported that the road network and further to this the cost of transporting milk were the main reasons why they never took their milk to the collection center. This

Table 2. Quality control of raw milk at the selected milk collection centers

Name of collection center	Quality control tests	Amount of milk that fails tests	Frequency of milk rejection.	Milk losses (%)
Wanyororo Dairy Cooperative Society	Alcohol test, lactometer test & clot on boiling test	50-100 liters-rainy season/month 10-20 liters-dry season/month	At least 2 times/week-rainy season At least twice a month-dry season	0.2%-0.4% - rainy season/month 0.04%-0.08% -dry season/month
Olenguruone Dairy Cooperative Society (Olenguruone)	Alcohol test and lactometer test	100-150 liters-rainy season/month 300 liters-dry season/month	At least 2 times/month-rainy season At least 4 times/ month-dry season	1.67%-2.5% rainy season/month 3.33%-dry season/month
Olenguruone Dairy Cooperative Society (Kaplamai)	Alcohol test and lactometer test	5 liters-rainy season/month 10 liters-dry season/month	At least once/month-rainy season At 4 times/ month-dry season	0.45% - rainy season/month 0.90%-dry season/month

would result into selling the milk to neighbours or to intermediaries in this case traders who took milk to the centers or sold it to other outlets including shops and hotels. Poor roads contributed to delay in delivering milk at collection centers. During rainy season the situation was worse which made it impossible for some farmers to get their milk to the centers. Those who manage to deliver their milk to the centers during this season, mainly using transporters on motorbikes and donkeys reported many cases of milk rejection. Majority of farmers however took their milk to the collection centers despite of all these factors. All these farmers were members of cooperative societies that owned the collection and bulking centers in the study region. Table 1 shows status of the selected collection centers in terms of milk collection and bulking.Wanyororo dairy cooperative society collection center collected about 800liters/day. The transporters taking their milk to this center reported an average of 3 to 4 hours taken to get milk there. The same was reported during the farmers interviews as they estimated milking time, time the milk is picked at their gates by transporters and estimated time these transporters take to deliver the milk at the centers (based on their knowledge about distance between their homes and the collection centers). Operators of the collection centers reported similar time for arrival of transporters. As for Olenguruone Dairy Cooperative Society collection centers, Olenguruone branch collected about 6000 liters/day. The Kaplamai branch on the other hand collected about 1100 liters/day. The transporters taking milk to both centers reported an average of 3 to 5 hours taken to deliver milk at the centers.

Table 3. Utilization of rejected high acid milk

Name of collection center	Study region	Product development (Mainly naturally fermented milk)	Disposal of this milk	Feeding it to animals	Sale to neighbours.
Wanyororo region (n=100 farmers)	Dundori	65%	5%	2%	18%
Olenguruone region (Olenguruone) (n=60 farmers)	Olenguruone	98%	1%	0.5%	0.5%
Olenguruone region (Kaplamai) (n=45 farmers)	Olenguruone	94%	4%	1%	1%

Safety and quality of raw milk at milk collection centers

Management and operators of milk collection centers had systems of quality control for the milk they received. This was done to segregate poor quality milk. Most of the commonly performed quality control tests were the alcohol test and lactometer test. It was reported during the interviews that these two tests were effective, rapid, that is, not time consuming and required minimal resources to carry out. Milk rejection was based on failure of these tests. Failure of the alcohol test indicated developed acidity in milk whereas milk that failed the lactometer test indicated milk adulteration using water or solids. This milk was not considered for further processing. Physico-chemical composition and chemical safety of both accepted and rejected milk were not determined. Table 2 shows quality control tests performed at the selected milk collection centers, amount of milk that fails tests performed and frequency of milk rejection. Larger volumes of milk were rejected during the rainy season in Dundori region. In Olenguruone region, it was reported that larger volumes of milk were rejected during the dry season. Significant milk losses were noted as a result of milk rejection.Wanyororo dairy cooperative society collection center in Dundori reported 50-100 liters of milk failing quality control tests per month during the rainy season and 10-20 liters during the dry season. This was translated into about 0.2%-0.4% milk loss as a result of milk rejection during the rainy season and about 0.04%-0.08% during the dry.Olenguruone Dairy Cooperative Society collection centers, Olenguruone and Kaplamai branches reported 100-150 liters of milk failing quality control tests per month during the rainy season and 200 liters/month during the dry season and 5 liters/month during the rainy season and 10 liters/month during the dry season respectively. This was translated into about 1.67%-2.5% milk loss as a result of milk rejection during the rainy season and about 3.33% during the dry for the center at Olenguruone. At the Kaplamai branch milk loss as a result of rejection was translated into 0.45% during the rainy season and 0.90% during the dry.

Utilization of rejected high acid milk

The milk that failed the alcohol and lactometer tests was rejected. This rejected milk was returned to individual farmers or transporters. Most of this milk was fermented naturally, that is, stored in containers and left to ferment for 2 to 3 days, to make traditional fermented milk. Other farmers reported disposal of the milk, fed it to animals and/or sold it to neighbours.Besides tea and raw milk, traditional fermented milk was a preferred form of milk consumption. The extension workers reported offering safety and quality training as far as hygienic raw milk production and storage is concerned. Training to the persons who prepare milk products, mostly the fermented milk, is minimal. Table 3 shows different ways in which rejected high acid milk was utilized in the selected rural and peri-urban farming systems in Nakuru County, Kenya.

DISCUSSION

Small-scale milk producers very often form associations, self-help groups or cooperative societies in order to market their milk more efficiently by pooling their resources and the quantities of milk each of them produces (Kurwijila, 2006).Dundori and Olenguruone dairy sub-value chains in Nakuru County have such organized milk collection and bulking systems where individual dairy farmers take their milk to a dairy cooperative society's milk collection centers. Majority of

Figure 6. A case of milk rejection at the milk collection center. Alcohol test is carried out on the milk brought by the transporter. The results of the milk are shared with the transporter and the milk rejected.

the farmers who taken their milk to the centers are mostly members of the cooperative societies that own these centers. By virtue of being members and the centers being a source of good market price for milk, the collection and bulking of milk is considered important in these study regions. Road network and transportation costs are some challenges which when addressed may increase number of farmers and volumes of milk being collected. Poor road network results in many hours taken to transport milk to the collection centers. This majorly contributes to deterioration of milk quality mainly because of the uncontrolled temperatures as the milk is being transported. This leads to many cases of milk rejection. Poor hygiene of milk containers also contributes to many cases of milk rejection. This may explain the higher cases of milk rejection in Olenguruone region during the dry season compared to the rainy season. The availability of water during the rainy season may lead to better hygiene of milk container therefore lesser microbial contamination. The high environmental temperatures during dry season may also contribute to developed acidity in milk hence rejection.

Simple platform tests carried out enable the centers to ensure that only good quality milk is accepted for onward transportation to milk processing factories. Such tests including: organoleptic test, alcohol test, and lactometer test may not be sufficient since the physico-chemical composition and chemical safety of both accepted and rejected milk is not determined. The stability of milk components is not understood therefore leading to disposal of high acid milk or adulterated milk that may be processed into other dairy/milk products.

The availability of milk for the preparation of milk products on the other hand, depends on many factors including: the total amount of milk produced, quantity of the milk dispatched to industrial dairy factories and quantity retained by the milk producer for the direct use of the household, for the preparation of milk products for local sale, or for use in calf rearing. Regions that have highest quantities of milk being used for preparation of dairy products on the producer's farm or household, or local small processing units usually have a dairy industry which is less developed (Kurwijila, 2006). In addition to this, it is only good quality milk that is highly preferred for product development. Any milk that is considered of low quality is least preferred but may not be completely left out for preparation of dairy products particularly traditional fermented milk.The preference of milk consumption in the form of home-made fermented milk is also reported by Ouma et al., (2000)

The condition of roads between the milk-producing areas and the urban areas was also important in determining how milk is utilized. Poor access roads and impassable ones during the rainy season leads to rejection of milk at collection centers due to deteriorated quality as a result of poor handling and the time taken to reach markets (FAO, 2011). The rejected milk is not considered for processing. However its utilization had not

been documented. Contribution of milk rejection to milk losses is the only aspect reported as more than 6% loss of total production (Muriuki, 2003). Despite the milk being considered not suitable for processing, farmers channel it to other uses that may not earn them any economic value but some functional value is achieved.

CONCLUSIONS AND RECOMMENDATIONS

Collection and bulking of milk in the study regions is faced with challenges to in terms of time taken to transport milk from the farms and the insufficiency of quality control tests carried out. Many hours and uncontrolled temperatures under which milk is transported leads to deteroriation of milk quality. The milk mostly fails the alcohol test which is the most common quality control test carried out. The physico-chemical composition and chemical safety of the milk that fails the alcohol test is however not understood since no analysis is done with this respect. This may lead to disposing off milk that may be further processed into other milk products. The study therefore concludes that once safety and physico-chemical quality of high acid milk is determined, appropriate technologies for processing can be used to develop milk products. Minimal industrial (processing) infrastructure that can be accessed by small-scale processors can be used. This would ensure appropriate processing of rejected milk and production of safe products unlike the traditional fermented milk that is commonly produced without standard procedures and safety of the raw material and final product is not ascertained.

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