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Effects of Culturing Raw milk using Informal Procedures on Quality, Consumer Preference and Gross Margin of Mala in Nakuru County, Kenya

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Abstract

Smallholder dairy farmers and informal raw milk traders in Nakuru County, Kenya prefer to store the product for about five days. Within the five days, the raw milk is available for consumption in the household and selling. This ensures regular supply, enhancing food security and better price of the product. Currently both the supply and prices are poor since raw milk can only be stored for six hours after being milked from the cows. The problem is caused by lack of appropriate affordable procedure of processing raw milk that can prolong storage period as way of value addition to raw milk. A study was carried out to evaluate various fermentation procedures used by smallholder dairy farmers and informal milk traders in processing cultured or sour milk. The processed sour milk or cultured raw milk is locally referred to as Mala. Mala is characterised by a sour taste and a prolonged storage life. The two characteristics vary depending on the method used during the fermentation process. In Nakuru County various methods of culturing raw milk into Mala are used, however none of them has been evaluated for quality, preference and gross margin. Smallholder dairy farmers and informal milk processors in Nakuru County were interviewed using structured questionnaires on procedures of processing Mala, shelf-life and gross margins of product. Three methods of processing Mala products were found to be used by Smallholder dairy farmers and informal milk processors. Three Mala products were prepared in Food and Science Laboratory, Egerton University using similar procedures being practised in the field. Both field and Laboratory prepared Mala products were evaluated for Total Viable (TC) and Coliform Counts (CC), pH, lactic acid levels, consumer preference and gross margins. Data collected was analysed and procedure one, was found to be most appropriate for preparing raw milk into Mala that can be used by smallholder farmers and informal milk processors.

Keywords: Informal, milk fermentation, procedures, Nakuru County, Kenya

Introduction

Milk is a major component in human diet all over the world, for both urban and rural Kenyans (Ali, 2010; Majiwa, 2012). It provides means of livelihood to smallholder dairy farmers of Nakuru County, Kenya (Kinambuga, 2010).

In Nakuru County, one way, farmers (32%) dispose raw milk is through selling to informal market participants (kiosks, milk bars and milk dairies). This is because the payment is on time and higher.

To add value, smallholder dairy farmers and Informal milk traders culture raw milk into Mala (sour/fermented or cultured milk) (Birachi, et al. 2006). Mala is made by use of special lactic acid bacteria cultures, which grow well at ambient temperature (25-30°C) referred to as mesophilic starter cultures. Variation in the flavour, texture, consistency and shelf-life of Mala depends on the procedure used during the preparation. The shelf-life of Mala (at ambient temperature) is about 4 days compared to 24 hours for flesh pasteurized milk. Preparation of Mala vary depending on procedures and types of lactic starter cultures used. Use of some Mala from certain procedures has been even cautioned (FAO, 2004). Mala is nutritionally better in quality, possesses therapeutic properties and can be consumed by "lactose intolerant" individuals (FAO, 2004).

Consumption of Mala is at household levels and milk bars where it is sold to consumers (Birachi, et al. 2006). Mala is preferred because it increases economic value and economic appeal of a raw milk (Odero-Wanga, et al., 2009).

Objectives

So far none of the existing procedures of preparing that have been used by Smallholders dairy farmers and Informal milk traders has been evaluated. One of objective of the study was to identify and evaluate methods used by Smallholders dairy farmers and Informal milk traders.

The other objective was established an appropriate fermentation method that can be used by Smallholders dairy farmers and Informal milk traders for processing raw milk into Mala.

Materials and Methods

Survey

A survey was carried out in farms and trading centres in three ward representatives of Njoro Sub-County; Kihogo, Njokerio, Ndeffo and RVIST, Mbogoini in Subukia Sub-County and Nakuru town in Nakuru County. Informal milk traders were interviewed using structured questionnaires mainly on procedures used in processing Mala, shelf-life and gross margins of product.

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Procedures of preparing mala

Using three procedures used by Smallholders dairy farmers and Informal milk traders, three Mala A, B, and C were processed in Department of Food Science laboratories, Egerton University in Nakuru County. Three Mala were processed using the following procedures; One; (Boiled Cultured milk- BC), raw milk was boiled inside aluminium cooking pot to a temperature of 80oC, left to cool down to 40oC by reducing the heat intensity and left (steeped) for 2 hours at the same temperature. The steeped milk was then removed from the source of heat and left to cool down to room temperature (20-25oC). It was later put in a five-litre plastic container and a mother culture from a factory processed cultured milk was introduced at a rate of 100ml per litre before incubating it for 36 hours, the final product was coded Mala A.

Two; (Boiled Uncultured-BU), raw milk, same as in procedure 1 and left to cool down to room temperature (20-25oC) before being incubated for 60 hours, the final product was was coded mala B.

Three; (Unboiled Uncultured-UU), raw milk was incubated in a five-litre plastic container under room temperature (20-25oC) for 54 hours, the final product was coded Mala c.

Parameters and analysis

Samples of Mala (A, B and C) prepared by the Smallholders dairy farmers and Informal milk traders (Field based) were also collected from the study areas. Both the laboratory and field based samples were analysed for the following parameters;

1. Total Viable Counts (TVC) and Coli (CC) according to Umbreit, W.W. (1992),

2. pH and Lactic acid concentration at an interval of 12 hours using standard lactic acid titration procedures according to Stocking W.A (1998).

3. Consumer preference - using hedonic scale of following ratings (like-very-much-5, like-4, neither-3, dislike-2 and extremely dislike-1) a sensory evaluation of both field and laboratory based product was conducted. A panellist of 41 persons of unhomogenised (different) ages evaluated the field prepared Mala while, 42 persons of homogenised (similar) age evaluated laboratory prepared mala.

4. Shelf life - The three laboratory based products were left on a shelf to observe no of days it took them to get spoilt, through sniffing them daily.

5. Gross Margins - Simple calculations were used to calculate gross margins.

Data analysis

Data on parameters i) and ii) were subjected to analysis of variation (ANOVA) using one way general linear model (GLM) of SAS, 2003 and means separated by least significant difference (lsd). Data on parameter iii) was analysed using Statistical Package for Social Science (SPSS).

Results

Three Mala processing procedures were found being practised within the study area;

1. Procedure One, in Nakuru town, Njoro, Njokerio, RVIST and Subukia.

2. Procedure Two, in Nakuru town, Njokerio and Subukia

3. Procedure three, was observed in Kihingo and Ndeffo.

There was significant difference (P<0.05) in the population of both TVC and CC in both laboratory and field mala. Mala C both laboratory and field based had the highest TVC and CC (Table 1),

Table 1. Types and no. of microbes (millions) in the various field and laboratory based products

	A (boiled cultured)		Product B (boiled uncultured)		C (unboiled uncultured)	
Type. of Microbe	**Field**	**Lab**	**Field**	**Lab**	**Field**	**Lab**
TVC	10.48^{b}	9.40^{b}	8.80^{c}	7.40^{c}	22.30^{a}	19.0^{a}
CC	8.80^{b}	7.30^{b}	7.60^{c}	5.73^{c}	9.70^{a}	8.60^{a}

Means followed by different superscript in the same row of the same source are significantly different (P<0.05).

Mala B both laboratory and field based had least population (P<0.05) of the TVC and CC (table 1), mala A had medium population (P<0.05) of TVC and CC (Table 1).

Field based mala had higher population (P<0.05) of TVC and CC than the laboratory prepared (table 1).

The pH of various laboratory prepared Mala reduced with the progression of time (table 2).

There was significant increase (P<0.05) in levels of lactic acid (Table 3). There was significant difference (P<0.05) in the taste preference of three different mala, both laboratory and field prepared (Table 4).

Mala A was the most preferred (P<0.05) in the laboratory and field (table 4). Mala C was highly (P<0.05) preferred in the field than laboratory (Table 4), while Mala C, laboratory based prepared was the least.

Table 2. pH levels (10-1) of the various laboratory based Mala

Product			
Hours	**A (Boiled Cultured)**	**B (Boiled Uncultured)**	**C (Unboiled Uncultured)**
0	6.36[a]	6.36[a]	6.36[a]
24	5.50[b]	6.30 [a]	4.85[b]
36	4.19[c]	6.19 [a]	4.30 [b]
42	4.01[d]	6.22 [a]	4.18 [b]
64	4.00[d]	5.27[b]	4.15 [b]
72	4.00[d]	4.58[c]	4.17 [b]

Means followed by different superscript in the same column are significantly different (P<0.05).

Table 3. Lactic acid levels (10-1) of the various laboratory based mala products

Mala product			
Hours	**A (Boiled Cultured)**	**B (Boiled Uncultured)**	**C (Unboiled Uncultured)**
0	2.8[a]	2.8[a]	3.6[a]
24	6.3[b]	2.9[a]	9.4[b]
36	12.6[c]	3.7[a]	11.6[c]
42	13.6[d]	3.8[a]	12.7 [c]
64	14.1[d]	6.6[b]	13.2 [c]
72	15.0[d]	10.8[c]	14.4 [c]

Means followed by different superscript in the same column are significantly different (P<0.05).

Table 4: Hedonic scale of the various field and laboratory based mala products

Mala									
	A (Boiled Cultured)			**B (Boiled Uncultured)**			**C (Unboiled Uncultured)**		
	N	**Mean**	**Std. error**	**N**	**Mean**	**Std. error**	**N**	**Mean**	**Std. error**
Field	42	3.90[a]	0.261	42	3.07[c]	0.27	42	3.74[b]	0.25
Lab	41	4.32[a]	0.128	41	3.54[b]	0.14	41	2.84[c]	0.2

Means followed by different superscript in the same row are significantly different (P<0.05).

The shelf-life was six, four and three days for mala A, B, and C respectively. Apart from the shelf-life, the gross margin of sale of product was between 65% and over 100% in comparison to raw milk. In Kihing'o, relatively in rural areas, the price of raw milk KES18.00 per litre and the price of Mala C was KES 30.00 per litre giving a gross margin of Kshs 12.00 per litre that is 67%. In Njokerio, an area that is highly populated area, and neighbouring Egerton University, the price of raw milk was KES 20.00 per litre while mala A was KES 45.00 per litre giving a gross margin of more than 125%. In Nakuru town with high population, a litre of raw milk costed KES 20.00 per litre and Mala B was selling Kshs 36.00 per litre giving a gross margin of 80%. In Subukia Centre, relatively in rural areas, Mala A was sold at Kshs.30.00 per litre while raw milk costed Kshs. 15.00 per litre giving a margin of 100% per litre.

Discussion

Total viable and coliform counts detected in the three mala from two sources (field and laboratory) could have originated from milk handling equipment. In some cases, it was observed that certain Smallholders dairy farmers and Informal milk traders did not even wash the containers after emptying the previous Mala, this is in agreement with Foley (1985). Coliforms counts detected could be an indication of mala being contaminated with the faecal matter, which is in agreement with (Hempen et al (2004).

High population of TVC and CC in Mala C, both field and laboratory based was attributed to lack of heating raw milk during processing of the product which is in agreement Withers and Couper (2012). Lowest population of TVC and CC were found in Mala B. This was attributed to heating the raw milk during the processing of Mala B. The heating could have destroyed the microbes in the raw milk. Later the microbes were spontaneous introduced from the environment. These could be the microbes which were responsible for the fermentation. The microbes were destroyed during heating of the raw milk. This caused a lag in the build-up of the acid due absence of microbes. Build-up of acid relied on the spontaneous introduction of the microbe from the environment which took time to multiply. This caused the processing of Mala B to be long to ready than in others. The average population of TVC and CC were found in Mala A. This could have been resulted from the microbes introduced by the mother culture after the raw milk was heated.

The pH of the mala reduced with progression of time. This could have been an indication of formation of an organic acid. Organic acids are usually weak acids hence pH could not have gone below 4.00. Acidic levels in Mala of pH 4.00 causes the destruction lactobacillus bacteria. Absence of bacteria brings to a stop any further production of organic acid, hence pH being maintained at 4.00.

Preference of Mala was highly related with organic acids present of in the product. The laboratory, Mala A which was most preferred could be due to lactic acid. Lactic acid could have been the only organic acid in Mala A. Lactic acid in Mala A could have been formed as a result introduction of one type of bacteria. The bacteria was inoculated from the mother culture, commercial prepared product. Apart from Mala A, being preferred in the labolatory, Mala C was preferred in the field. This was because the panelists in the laboratory were from same age group and locality (university students). On the other hand, field panellists comprised of different ages groups and localities, mainly adults, available in the trading centres during the interview. This could have contributed Mala C being preferred in the field.

When the evaluation was done in the laboratory Mala B preferred than Mala C. During the processing of Mala B the fermentation was mainly by naturally occurring lactic acid bacteria. This caused the taste to be better than mala C. Mala C was as a result of fermentation using a mixture of microbes synthesising various end products which is in agreement with (Umbreit, 1992). Since these end products were within Mala C, the product ended with unappealing taste. Apart from preference shelf-life of the product was evaluated.

Shelf life, a period product took to get spoilt after being ready. Shelf life of the product was related to duration the Mala took to be ready. This was attributed to the chemical composition of milk. The compound takes the same life span to be transformed during the processing. The life span is however, is apportioned between the pre-fermentation and post fermentation. This implies that products that take shorter period for fermentation to complete had longer the shelf-life and vice versa. There was increased gross margin of Mala compared to raw milk, hence processing Mala can be considered as value addation practise.

Conclusion and Recommendations

Mala A was the most preferred in terms of hygiene, taste and shelf- life. Procedure One, was recommended as the standard procedure that can be used to process raw milk into Mala by both smallholder farmers and informal milk traders. The procedure was also found to be affordable method of adding value to raw milk in terms flavour, texture, consistency, shelf-life and gross margins. During the processing of Mala high level of hygiene should be observed. Equipment should be sterilized to reduce the number of microbes that contaminate mala.

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