



Processing Practices and Quality of Dairy Products in Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Dairy industry is playing an increasing role in food security and economics of West African countries. However there is a need for more information on the quality and history of the dairy products found on the local markets in order to guide necessary reformations in this sector. The objective of this study was to provide data on the quality and processing practices of dairy products, including some locally manufactured dairy products and imported powder milk commercialised in Burkina Faso. Specifically, a survey was carried out first, to identify the locally manufactured dairy products as well as the manufacturing practices, particularly the malpractices not yet reported in the

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literature. Then, locally manufactured dairy products (excluding the traditionally fermented milk *lait caillé* and pasteurised milk), imported powder milk from brands frequently used for processing milk products and fraudulent practices identified during the survey were evaluated through laboratory analyses. Physico-chemical parameters such as pH, acidity and moisture content were determined. In addition microbiological parameters such as aerobic mesophilic flora, yeast and mold, thermotolerant coliforms or enterobacteria, were also determined.

Results from the survey showed that good manufacturing practices were not strictly observed. In addition it was reported use of salt and a popular street medicine “*toupai*” (supposedly an antibiotic) for delaying the spoilage/fermentation of the raw milk. Six types of locally manufactured milk products were identified while seven brands of powder milk were frequently used, after repackaging, for processing milk products. Most samples of locally manufactured products were unsatisfactory for fungal and thermotolerant coliforms loads. Powder milk samples showed absence of enterobacteria. Sensory analyses showed that locally manufactured products from powder milk were more appreciated than those made from raw milk. Attempts to reproduce the malpractices of using salt or “*toupai*” did not lead to significant results compared to the control, suggesting that some respondents did not fully open up about the malpractices. These data are useful since they would give tools to policy makers for quality control and regulation in the sector of dairy products.

Keywords: Dairy products; powder milk; quality control; fraudulent practices; Burkina Faso.

1. INTRODUCTION

Milk and dairy products play an important role in the economy of many countries and in the global trade. Indeed, farmers in certain economic regions of the world (European Union) had been imposed production quotas then later cancelled while industries in other countries have suffered accusations of malpractices relating to voluntary substitution of milk natural constituents by unauthorized elements (Handford et al., 2016). Particularly for West African countries, the dairy sector is important because of nutritional, economic and cultural aspects (Handford et al., 2016), [1,2]. Indeed, the dairy industry is playing an increasing role in the food security and economics. In Burkina Faso in particular, the economy depends essentially on the agro-pastoral sector. Local dairy products benefit from the national context of promotion of locally manufactured products and the increasing demography [3,4,5,2]. However, the main stakeholders in the dairy sector are increasing their advocacy for greater support. Indeed many calls are made for building the capacities of the main actors and for new legislation in order to reach an autonomy in this food sector [1,2]. Although the type of dairy products found in Burkina Faso and other West African countries may be quite similar, there is need of more information on the issues, the origins and the quality of the dairy products found on local markets in order to guide the reformations [3,4,5].

The objective of this study was to provide data on the quality and processing practices of dairy products, including some locally manufactured dairy products and imported powder milk commercialised in Burkina Faso. The local traditional curdled milk (*lait caillé*), and the pasteurised milk which have already been much investigated [6,7,8] were not included. Specifically, a survey was carried out to identify the locally manufactured dairy products as well as the manufacturing practices particularly the fraudulent ones not yet reported in the literature. Then, locally manufactured dairy products (excluding the traditionally fermented milk *lait caillé* and the pasteurised milk), imported powder milk from brands frequently used for local processing of dairy products and fraudulent practices identified during the survey were evaluated through laboratory analyses.

2. MATERIALS AND METHODS

2.1 Survey

A semi-structured survey was carried out on sellers from public markets and shops, processors owners of dairy units considered individually or grouped within an association in the city of Bobo-Dioulasso. In addition, breeders from the villages of Farakoba and Yegueresso were also involved. They were asked to report the known locally manufactured dairy products (Tables 1 and 2), the processing methods and any alternative way locally used to process or preserve dairy products (Table 3). The

characteristics of powder milk present on the local market were also reported by questionnaire and by visual observations (Tables 4 and 5).

2.2 Sampling

Samples of locally manufactured dairy products were selected in taking into account the nature of the raw material (raw milk or powder milk). For a dairy product locally manufactured and belonging to a given brand, 2 samples from each type of raw material (raw milk and powder milk or whichever available) were taken, at the processing site and at a selling point in the town. In total 15 samples corresponding to 8 brands were collected and transported in ice-box to the laboratory for analyses. Traditional *lait caillé* (traditional fermented milk) and pasteurised milk, which have been previously much investigated were not included.

Samples of imported powder milk from brands identified during the survey as mainly used for local processing of the dairy products reported by the survey, were also collected (Table 5). They were purchased in triplicate from three different selling points as they corresponded to repackaged powder milk samples. In total, 21 samples corresponding to 7 brands were collected throughout the city of Bobo-Dioulasso and transported to the laboratory for analyses.

Following the report of some fraudulent practices, attempts were made in laboratory to reproduce the malpractices in order to analyse the end-products quality. For this purpose, raw milk from manual milking was sampled in a farm located at Farakoba village a rural neighbourhood of Bobo-Dioulasso, and transported in ice-box to the laboratory for analyses.

2.3 Determination of pH, Acidity and Moisture Content

Acidity was determined by volumetric titration using KOH solution (0.1N) on locally manufactured dairy products while pH values were determined with a pH-meter (Hanna, USA) on locally manufactured dairy products and powder milk samples. On these samples, moisture content was also determined by differential weighing before and after air oven (Mettler, Germany) drying at 103°C until constant weigh (Tables 1 and 5).

2.4 Determination of Microbiological Counts

Microbial counts were performed on locally manufactured dairy products and powder milk samples (Table 1; Figs. 1 and 2). Aerobic mesophilic flora (AMF) counts were determined on Nutrient agar after aerobic incubation at 30 °C for 72 h according ISO 4833 [9], while yeasts and molds counts were determined on Nutrient agar supplemented with gentamicin (pH adjusted at 5.6 ± 0.2) following aerobic incubation at 30 °C for 72-96 h (ISO 1988), [10]. Enterobacteria were enumerated for locally manufactured dairy products on Violet Red Bile Glucose (VRBG) agar (Liofilchem, Italy) after 24 h at 37 °C, while thermotolerant coliforms were counted on Violet Red Bile Lactose (VRBL) agar after 24 h incubation at 44 °C [11].

2.5 Sensorial Analyses

Samples of yoghurt and *gappal* from both raw milk and powder milk were subjected to sensory analyses (Fig. 3) by a panel of 20 adults who performed colour, aroma, texture and taste evaluations on a scale of 3 points [12].

2.6 Assessment in Laboratory of Fraudulent Practices

Based on the reports of some fraudulent practices, attempts were made in laboratory to reproduce the malpractices.

For this purpose, salt (NaCl) were purchased at market and distributed into 03 flasks (B, C, D) containing 500 ml of raw milk. The final concentrations were: B = 0.00057g/ml, C = 0.00114g/ml, D = 0.00228g/ml. A negative control (A) was done with 500 ml of raw milk without adding of salt. All the treatments were homogenized, then incubated at 37°C in an incubator (Mettler, Germany). The pH, acidity of each treatment were measured as previously described at T=0h; T= 6h; T=12h and T=24h of incubation (Fig. 4). AMF loads were also determined as previously described at T=0h; T=12h and T=24h of incubation (Fig. 5).

Similarly, based on the reports, a popular street medicine "*toupai*" (supposedly an antibiotic) was also purchased and distributed into 5 flasks of 100 ml of raw milk (I, J, K, L and M). The final concentrations were: (I=0.002g/ml; J=0.001g/ml; K=0.0005g/ml; L=0.00025g; M=0.000125). A

negative control H was done with raw milk without adding of “*toupaï*” (Fig. 6). The flasks were homogenized then incubated at 37°C. The pH and acidity of each sample were recorded at T=0h; T= 6h; T=12h and T=24h of incubation. AMF were also determined as previously described at T=0h; T=12h and T=24h of incubation (Fig. 7).

3. RESULTS AND DISCUSSION

3.1 Characteristics of Locally Manufactured Dairy Products

The survey to identify the locally manufactured dairy products revealed the presence of two types of products (Table 1). A first group characterized by a combination of cereals (principally millet dough product) and fermented milk (*dèguè*, *gappal*); and a second group constituted of products deriving only from milk (cream, *wagashi*, *lait caillé*, yoghurt and pasteurised milk)

Results from physicochemical analyses (Table 2) on local manufactured dairy products (*dèguè*,

gappal, cream, *wagashi*, yoghurt) revealed that the pH of the samples varied between 3.78 and 6.88. The acidity was between 3.35 and 155.68°D while the moisture content varied between 57.55% and 80.29%. Microbiological analyzes showed that the aerobic mesophilic flora loads were between 10⁶ and 2.2 10⁸ CFU/g. Yeast and mold loads were ranging between 10² and 1.0 10⁷ CFU/g while thermo tolerant coliforms loads were ranging between 0 to 1.3 10² CFU/g.

The survey also revealed inadequacies in the flow process of locally manufactured dairy products (Table 3). Some of them were the lack of segmentation in some processing facilities, the insufficiency in control of the raw milk at the reception and the no respect of pasteurisation scale. Some fraudulent practices (Table 3) were reported such as the use of salt for delaying the spoilage/fermentation of the raw milk and the use of a street medicine, (most probably an antibiotic) locally name *toupaï* for delaying the spoilage/fermentation of the raw milk. However, the respondents did not precise the concentrations

Table 1. Commercially available local dairy products identified during the survey in Bobo-Dioulasso

Local dairy products	Brief comments
<i>Dèguè</i>	It results from mixing large balls or small lumps of millet dough or couscous with fermented milk.
<i>Gappal</i>	It is made by mixing millet flour and fermented milk (liquid <i>gappal</i>) eventually followed by a drying step (dried <i>gappal</i>).
Yoghurt	Yoghurt is produced artisanally by small scale dairy processing units.
<i>Wagashi</i>	<i>Wagashi</i> is traditionally manufactured cheese from raw milk. Extract from <i>Calotropis procera</i> leaves and/or stem is added as coagulant to the raw milk.
Cream	Cream is traditionally removed from a spontaneously fermenting milk and essentially used in cosmetic
<i>Lait caillé</i>	The traditional soured milk obtained from spontaneous fermentation of raw milk (according the traditional process).
Pasteurised milk	Thermal pasteurisation of filtered raw milk (90-95 °C, 2-10 mn)

Table 2. Physico-chemical and microbiological characteristics of local manufactured dairy products in Bobo-Dioulasso

Dairy product	pH	Acidity (Dornic)	Moisture (%)	Aerobic Mesophilic Flora (log ₁₀ CFU/g)	Yeast and mold (log ₁₀ CFU/g)	Thermo-tolerant coliforms (log ₁₀ CFU/g)
<i>Dèguè</i> *	4.28±0.08	51.77±2.19	65.79±0.95	7.41±0.86	4.72±0.28	1.12±0.12
<i>Dèguè</i> **	4.13±0.14	64.87±2.96	69.15±4.04	7.70±0.74	5.01±0.24	1.76±0.02
<i>Gappal</i> *	3.93±0.21	136.85±26.63	72.92±1.08	6.96±0.73	5.29±0.10	ND
<i>Gappal</i> **	4.10±0.08	83.70±2.36	76.32±0.90	7.74±0.67	5.89±1.57	1.55±0.27
<i>Wagashi</i> **	6.88±0.00	3.35±0.00	57.55±0.00	8.08±0.00	3.51±0.00	2.11±0.00
<i>Yoghurt</i> *	4.21±0.16	102.14±13.05	75.16±2.47	8.04±0.42	4.73±0.38	ND
<i>Yoghurt</i> **	4.15±0.06	81.61±2.96	79.53±1.08	6.25±0.35	3.07±1.52	0.93±0.89
<i>Yoghurt</i> ***	4.16±0.12	98.77±7.11	75.89±0.66	8.15±0.14	4.72±0.69	ND

*: from powder milk; **: from raw milk; ***: from a combination of powder and raw milk; ND: Not detected

Table 3. Reports of main inadequacies observed in the flow process of locally manufactured dairy products (A) and of fraudulent practices (B) in the city of Bobo-Dioulasso

(A) Main inadequacies observed in the flow process	(B) Reports of fraudulent practices
No segmentation in the processing facility	Use of salt for delaying the spoilage/fermentation of the raw milk
No control of the raw milk at the reception	Use of an antibiotic (<i>toupai</i>) for delaying the spoilage/fermentation of the raw milk
No respect of pasteurisation scale	Use of a whitening agent in the raw milk
Post-pasteurization slow cooling to fermentation temperature	
Backslipping of old yoghurt	
No respect of the cold chain	

3.2 Characteristics of Commercially Available Powder Milk on Local Market

The characteristics of powder milk present on the local market are reported in Table 4. About 15 brands were identified representing whole and skimmed milk from various origins (as visible on the packaging). Among these brands, 7 were repackaged in local plastic packaging and compared to the other brands, they were the main used locally for dairy products manufacturing.

The mean values of pH and moisture (Table 5) on samples from brands mainly used for manufacturing dairy products were ranging from 6.08 to 6.72 and from 3.69 to 5.47 respectively.

Meanwhile no enterobacteria was detected in these samples. Loads of aerobic mesophilic flora and yeast and mold were more disparate as illustrated in Fig. 1 and 2.

When subjected to sensorial analyses of commercially available dairy products, results show that the products manufactured from powder milk were more appreciated than those manufactured with local raw milk (Fig. 3).

Table 4. Powder milk brands identified in Bobo-Dioulasso city

Shop N°	City area N°	District N°	Brand (on the packaging)	Whole/skimmed	Packaging	Storage place	Country of origin (on the packaging)
01	11	02	Nido	Whole	Plastic bag	Dry and cool	Ghana
02	11	02	Nido	Whole	Plastic bag	Dry	Pakistan
			Vreugde	Whole	Repackaged		The Netherlands
03	11	02	Maxo	Skimmed	Repackaged	Dry	China
04	11	02	Unknown	Unknown	Paper bag	On bare floor	Irland
05	11	02	Nido	Whole	Plastic bag	Dry	Pakistan
			Kosam	Whole			South Africa
06	22	07	Nido	Whole	Bottle	Dry and cool	Pakistan
			Ginny	Whole	Repackaged		The Netherlands
07	22	07	Kosam	Whole	Plastic bag	Dry	Mali
			Cowbell	Skimmed	Plastic bag		South Africa
			Vivalait	Whole	Repackaged		Togo
08	22	07	Nido	Whole	Bottle	Dry and cool	Ghana
			Vivalait	Whole	Repackaged		Togo
			Bonnet rouge	Whole	Bottle		Cote d'ivoire
09	10	02	Vivalait Nido	Whole	Repackaged	Dry	Togo
				Whole	Bottle		Ghana
10	10	02	H£H	Skimmed	Plastic bag	Dry	Burkina Faso
			Bonnet rouge	Whole	Bottle		Cote d'Ivoire
			Maxo	Skimmed	Repackaged		China
11	29	07	H£H	Skimmed	Plastic bag	Dry	Burkina Faso
			Pura	Whole	Repackaged		The Netherlands
12	29	07	Maxo	Skimmed	Repackaged	Dry	China
			Bonnet rouge	Whole	Bottle		Cote d'Ivoire
13	29	07	Nido H£H	Whole	Plastic bag	Dry	Ghana
				Skimmed	Plastic bag		Burkina Faso
14	21	07	H£H	Skimmed	Plastic bag	Dry	Burkina Faso
15	21	07	Chaya	Whole	Repackaged	Dry	The Netherlands
			Nido	Whole	Bottle		Pakistan

Shop N°	City area N°	District N°	Brand (on the packaging)	Whole/skimmed	Packaging	Storage place	Country of origin (on the packaging)
16	21	07	H£H	Skimmed	Plastic bag	Dry	Burkina Faso
17	20	06	Cowbell	Skimmed	Plastic bag	Dry	South Africa
18	20	06	Vivalait	Whole	Repackaged		Togo
19	20	06	Cowbell	Skimmed	Plastic bag	Dry	South Africa
20	15	04	Kosam	Whole	Plastic bag	Dry	Mali
21	15	04	Nido	Whole	Plastic bag	Dry	Pakistan
22	15	04	Kosam	Whole	Plastic bag		Mali
23	15	04	Pura Ginny	Whole	Repackaged	Dry	The Netherlands
24	15	04	Ginny	Whole	Repackaged	Dry	The Netherlands
25	15	04	Vivalait	Skimmed	Repackaged	Dry	Togo
26	15	04	Bonnet rouge	Whole	Bottle		Cote d'Ivoire
27	18	06	Nido	Whole	Bottle	Dry	Pakistan
28	18	06	Ginny	Whole	Repackaged	Dry	The Netherlands
29	18	06	Amor	Whole	Repackaged	Dry	Irland
30	03	01	Fortune	Unknown	Paper bag	On the bare floor	Irland
31	03	01	Vreugde	Whole	Repackaged	Dry and cool	Poland
32	02	01	Ginny	Whole	Repackaged	Dry	The Netherlands
33	02	01	Pura	Whole	Repackaged	Dry	The Netherlands
34	02	01	Vreugde	Whole	Repackaged		The Netherlands
35	02	01	Nido	Whole	Bottle	Dry	The Netherlands
36	02	01	Vreugde	Whole	Repackaged		The Netherlands
37	02	01	Nido	Whole	Bottle	Dry	The Netherlands
38	02	01	Amina	Whole	Repackaged		The Netherlands
39	02	01	Pura	Whole	Repackaged	Dry	The Netherlands
40	02	01	Amor	Whole	Repackaged	Dry	Irland
41	01	01	Vivalait	Skimmed	Plastic bag	Dry	Togo
42	01	01	Nido	Skimmed	Plastic bag	Dry	South Africa
43	01	01	Cowbell Chaya	Skimmed	Plastic bag	Dry	South Africa
44	01	01	Vivalait	Whole	Repackaged		The Netherlands
45	01	01	Amor	Skimmed	Repackaged	Dry	Togo
46	01	01	H£H	Whole	Repackaged		Irland
47	01	01	H£H	Skimmed	Plastic bag		Burkina Faso

Table 5. Moisture content, pH and enterobacteria load on powder milk samples from brands repackaged and mainly used for dairy products manufacturing.

Samples/Brands	pH	Moisture (%)	Enterobacteria (log ₁₀ CFU/g)
Amor1	6.65	5.32± 0.35	ND
Amor2	6.72	5.06± 0.07	ND
Amor3	6.70	4.98± 0.03	ND
Vreugde1	6.5	4.92± 0.1	ND
Vreugde2	6.24	4.72± 0.16	ND
Vreugde3	6.21	5.11 ± 0.61	ND
Ginny1	6.58	5.47± 0.12	ND
Ginny2	6.58	5.32± 0.35	ND
Ginny3	6.60	5.57± 0.04	ND
Vivalait1	6.11	4.48± 0.12	ND
Vivalait2	6.15	4.45± 0.09	ND
Vivalait3	6.08	4.47± 0.13	ND
Maxo1	6.33	3.76± 0.05	ND
Maxo2	6.33	3.69± 0.15	ND
Maxo3	6.30	3.71± 0.10	ND
Pura1	6.55	4.63± 0.03	ND
Pura2	6.70	4.72± 0.17	ND
Pura3	6.54	4.62± 0.13	ND
Chaya1	6.49	4.50± 0.08	ND
Chaya2	6.56	4.54± 0.17	ND
Chaya3	6.59	4.62± 0.06	ND

ND: Not detected

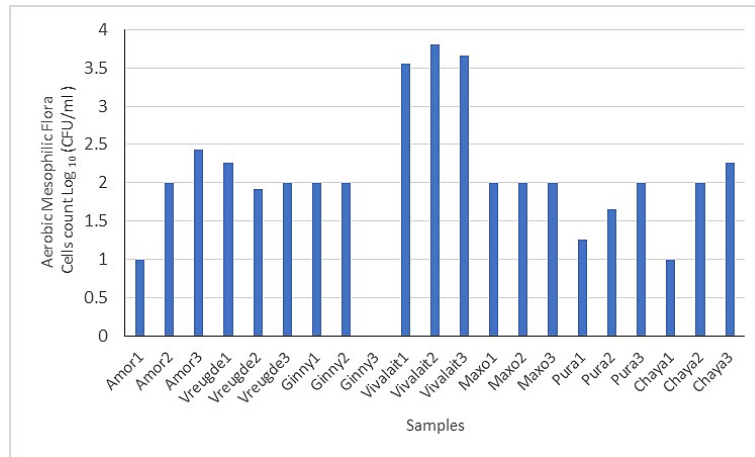


Fig. 1. Loads of aerobic mesophilic flora in powder milk samples used for manufacturing dairy products in the city of Bobo-Dioulasso

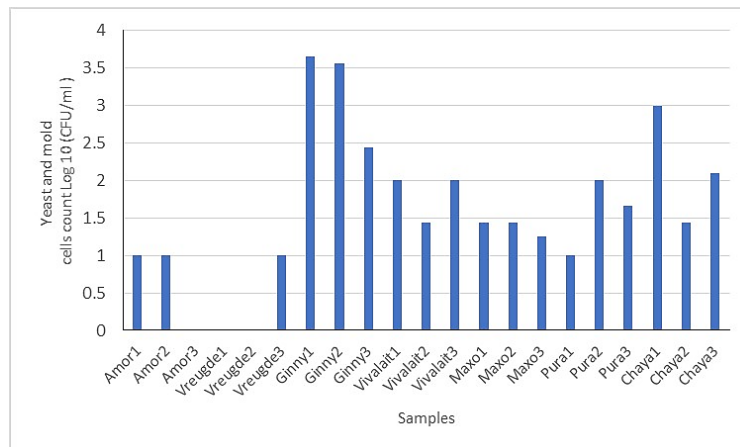


Fig. 2. Loads of yeast and mold in powder milk samples used for manufacturing dairy products in the city of Bobo-Dioulasso

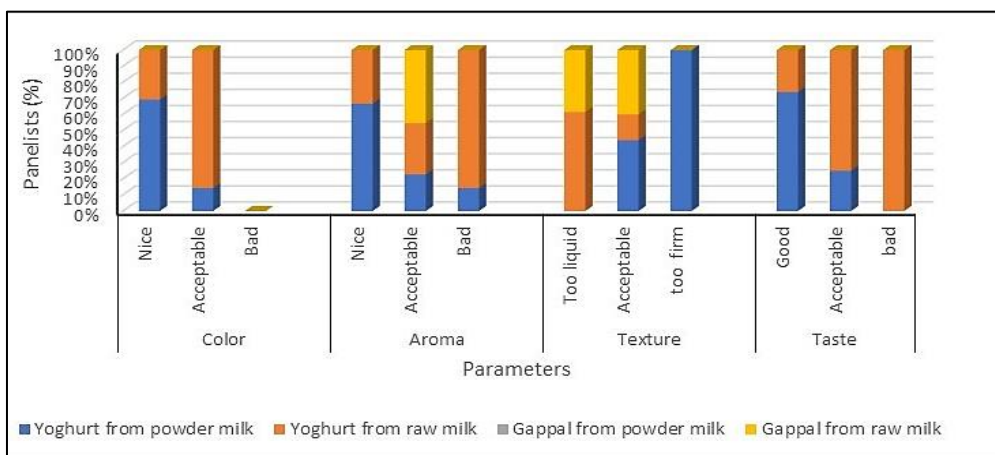


Fig. 3. Sensorial appreciations (%) of colour, aroma, texture and taste of yoghurt and *gappal* locally manufactured from local raw milk and imported powder milk

3.3 Characteristics of Fraudulent Practices

Following the report from the survey, the attempt to reproduce the malpractice of using salt to preserve raw milk lead to results on the evolution

of pH and acidity versus time for different NaCl concentrations in raw milk (Fig. 4) and pH and acidity versus time for different *toupaï* concentrations in raw milk (Fig. 6). The evolutions of aerobic mesophilic flora loads in the same conditions are also reported in Figs. 5 and 7.

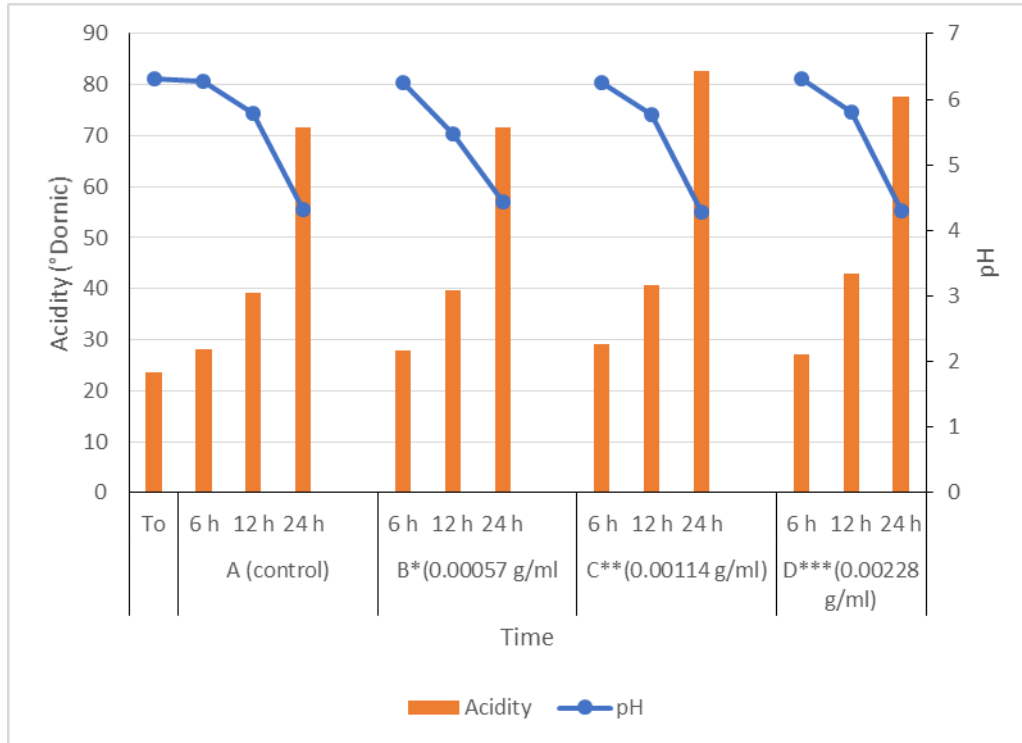


Fig. 4. Evolution of pH and acidity versus time for different NaCl concentrations in raw milk

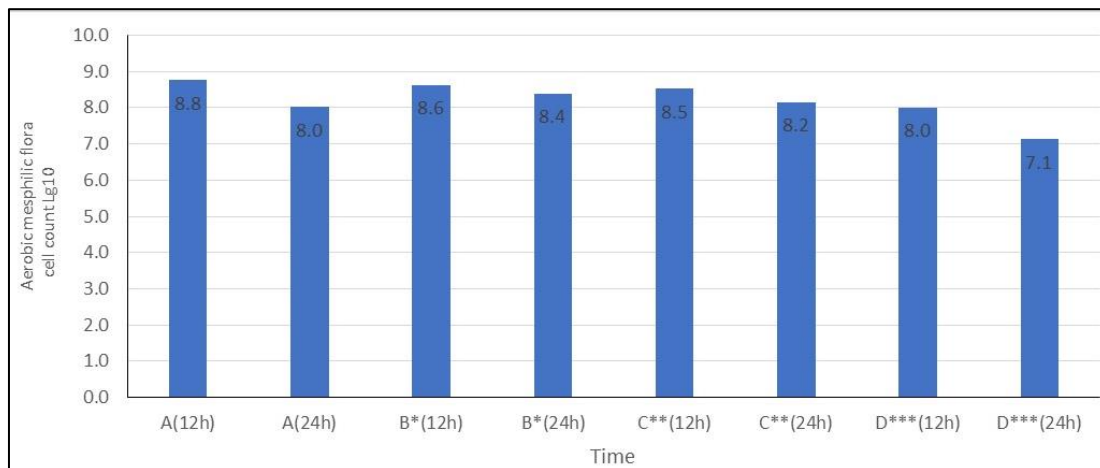


Fig. 5. Evolution of aerobic mesophilic flora loads versus time for different NaCl concentrations in raw milk: A (0g/ml); B*(0,00057g/ml) ; C**(0,00114g/ml) ; D***(0,00228g/ml)

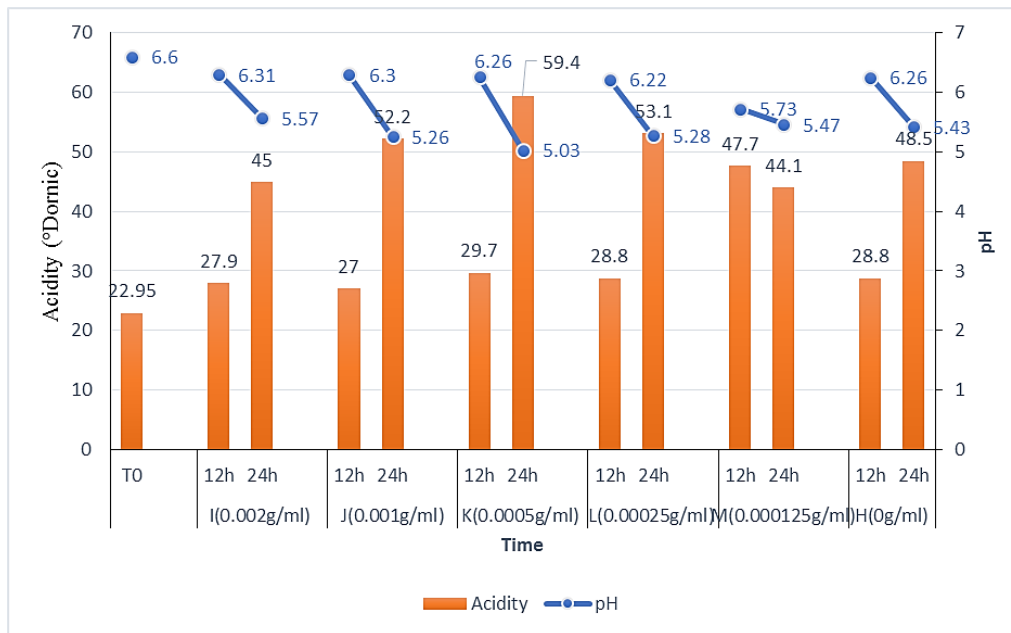


Fig. 6. Evolution of pH and acidity versus time for different *toupai* concentrations in raw milk

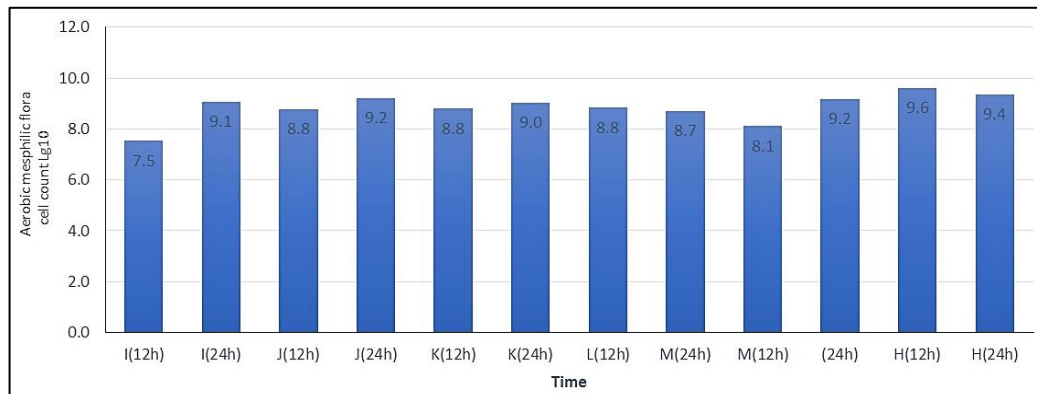


Fig. 7. Evolution of aerobic mesophilic flora versus time for different *toupai* concentrations in raw milk: H(0 g/ml); I(0,002g/ml) ; J(0,001g/ml) ; K(0,0005g/ml) ; L(0,00025g/ml) ; M(0,000125g/ml)

4. CONCLUSION

Inadequacies observed in the processing of locally manufactured dairy products related to insufficiencies in facilities suitability, quality control of the raw materials, pasteurisation and post pasteurisation handling. Some fraudulent practices were reported but experiments in laboratory were not able to reproduce them with evidence. Data also revealed relatively higher values in thermo-tolerant coliforms loads for samples from raw milk compared to samples from powder milk. The latter were better appreciated in sensory evaluation. These data should give tools to policy makers for quality control and regulation in the sector of dairy

products and insights to scientists for deeper investigations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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