Processing practices and quality of dairyproducts inBurkina Faso

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 andhistory of the dairy products found on the local markets in order to guidenecessary reformations in this sector.The objective of this study was to provide data on the quality and processing practicesofdairy products, including some locally manufactureddairy productsand 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 malpracticesnot yet reported in the literature. Then, locally manufactured dairy products (excluding the traditionally fermented milk *laitcaillé*and pasteurised milk), imported powder milk from brands frequently used for processing milk products andfraudulent practices identified during the surveywere evaluatedthrough laboratory analyses. Physico-chemical parameters such as pH, acidity and moisture content were determined. In addition microbiological parameters, aerobic mesophilic flora, yeast and mold, thermotolerant coliforms or enterobactria, were also determined.

Results from the surveyshowed 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 unsatisfactoryfor fungal and thermotolerant coliforms loads.Powder milk samples showed absence of enterobacteria. Sensory analyses showed that locally manufacturedproducts from powder milk were more appreciated than those made from raw milk. Attempts to reproduce themalpractices 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 andregulation 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) hadbeenimposed production quotas thenlatercancelled 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 (Corniaux, 2013; Handford et al., 2016; PASMEP, 2016). 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 (Broutin et al., 2018;Duteurtre and Vidal, 2018; FAO, 2016; PASMEP, 2016). 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 (Corniaux, 2013; PASMEP, 2016). 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 (Broutin et al., 2018;Duteurtreand Vidal, 2018; FAO, 2016).

The objective of this study was to provide data on the quality and processing practices of dairy products, including somelocally manufactured dairy products and imported powder milk commercialised in Burkina Faso.The local traditional curdled milk (*laitcaillé*), and the pasteurised milk which have already been much investigated (Bayili et al., 2019; 2022; Traore et al., 2022) 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 *laitcaillé* 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

1.1. 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).

1.2. Sampling

Samples of locally manufactureddairy productswere selected in taking into account the nature of the raw material (raw milk or powder milk). For a dairy product locally manufacturedand 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 collectedand transported in ice-box to the laboratory for analyses.Traditional *laitcaillé*(traditional fermented milk) and pasteurised milk, which have been previouslymuchinvestigated 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-Dioulassoand transported to the laboratory for analyses.

Following the report of some fraudulent practices, attempt were made in laboratory to reproduce the malpractices in order to analyse the end-productsquality. For this purpose, rawmilkfrom manual milking was sampled in a farm located at Farakobavillage a rural neighbourhood of Bobo-Dioulasso,and transported in ice-box to the laboratory for analyses.

1.3. Determination of pH, acidity and moisture content

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

1.4. Determination of microbiological counts

Microbial counts were performed on locally manufactured dairy products and powder milk samples (Table 1; Figures 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 (2003), 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 7954, 1988). 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 (NF V 086-060, 2009)

1.5. Sensorial analyses

Samples of yoghurt and *gappal* from both raw milk and powder milk were subjected to sensory analyses (Figure 3) by a panel of 20 adultswho performed colour, aroma, texture and taste evaluations on a scale of 3 points (Kemp et al., 2009).

1.6. 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 wasdone with 500 ml of raw milk without adding of salt. All the treatments were homogenized, then incubated at

37°C in an incubator (Memmert, Germany). The pH, acidityof each treatment were measured as previously described at T=0h; T= 6h; T=12h and T=24h of incubation(Figure 4). AMF loads were also determined as previously described at T=0h; T=12h and T=24hof incubation (Figure 5).

Similarly, based on the reports, a popular street medicine "*toupai*" (supposedly an antibiotic) was also purchased and distributed into 5 flasksof 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 "*toupai*" (Figure 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 (Figure 7).

3. Results& 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 (*Degue*, Gappal);and a second group constituted of products deriving only from milk (Cream, *Wagashi*,*laitcaillé* Yoghurtand pasteurisedmilk)

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

Local dairy products	Brief comments
Degue	It results from mixing large balls or small lumps of millet dough or couscous with fermented milk.
Gappal	It is made by mixing millet flour and fermented milk (liquid *gappal*) eventually followed by a drying step (dried *gappal*).
Yoghurt	Yoghurt is produced artisanally by small scale dairy processing units.
Wagashi	*Wagashi* is traditionally manufactured cheese from raw milk. Extract from *Calotropisprocera* 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
Lait caillé	The traditional soured milk obtained from spontaneous fermentation of raw milk (according the traditional process).
Pasteurisedmilk	Themalpasteurisation of filtered raw milk (90-95 °C, 2-10 mn)

Results from physicochemical analyses(Table 2)on local manufactured dairy products(*Degue, Gappal, cream, WagashiWagashi*, 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 10^6 and 2.2 10^8CFU/g.Yeast and moldloadswere ranging between 10^2 and 1.0$10^7$CFU/g whilethermotolerant coliforms loads were ranging between 0 to 1.3 10^2CFU/g.

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

Dairyproduct	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)
Degue*	4.28±0.08	51.77±2.19	65.79±0.95	7.41±0.86	4.72±0.28	1.12±0.12
Degue**	4.13±0.14	64.87±2.96	69.15±4.04	7.70±0.74	5.01±0.24	1.76±0.02
Gappal*	3.93±0.21	136.85±26.63	72.92±1.08	6.96±0.73	5.29±0.10	ND
Gappal**	4.10±0.08	83.70±2.36	76.32±0.90	7.74±0.67	5.89±1.57	1.55±0.27
Wagashi**	6.88±0.00	3.35±0.00	57.55±0.00	8.08±0.00	3.51±0.00	2.11±0.00
Yoghurt*	4.21±0.16	102.14±13.05	75.16±2.47	8.04±0.42	4.73±0.38	ND
Yoghurt**	4.15±0.06	81.61±2.96	79.53±1.08	6.25±0.35	3.07±1.52	0.93±0.89
Yoghurt ***	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

The survey also revealed inadequaciesin the flow process of locally manufactured dairy products (Table 3). Some of them were the lack of segmentation in some processing facility, the insufficiencyin control of the raw milk at the reception and the no respect of pasteurisation scale.Some fraudulent practices (Table 3) were reports 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 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 of the raw milk
No control of the raw milk at the reception	Use of an antibiotic (*toupaï)* 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	
Backslopping 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 arereported 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.

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 oforigin (on thepackaging)
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	Whole	Repackaged	Dry	Togo
			Nido	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	Whole	Plastic bag	Dry	Ghana
			H£H	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
16	21	07	H£H	Skimmed	Plastic bag	Dry	Burkina Faso
17	20	06	Cowbell	Skimmed	Plastic bag	Dry	South Africa
			Vivalait	Whole	Repackaged		Togo
18	20	06	Cowbell	Skimmed	Plastic bag	Dry	South Africa
			Kosam	Whole	Plastic bag		Mali
19	20	06	Nido	Whole	Plastic bag	Dry	Pakistan
			Kosam	Whole	Plastic bag		Mali
20	15	04	Pura	Whole	Repackaged	Dry	The Netherlands
			Ginny	Whole	Repackaged		The Netherlands
21	15	04	Ginny	Whole	Repackaged	Dry	The Netherlands
22	15	04	Vivalait	Skimmed	Repackaged	Dry	Togo
			Bonnet rouge	Whole	Bottle		Cote d'Ivoire
23	15	04	Nido	Whole	Bottle	Dry	Pakistan
24	18	06	Ginny	Whole	Repackaged	Dry	The Netherlands
25	18	06	Amor	Whole	Repackaged	Dry	Irland

26	03	01	Fortune	Unknown	Paper bag	On the bare floor	Irland
27	03	01	Vreugde	Whole	Repackaged	Dry and cool	Poland
28	02	01	Ginny	Whole	Repackaged	Dry	The Netherlands
29	02	01	Pura	Whole	Repackaged	Dry	The Netherlands
			Vreugde	Whole	Repackaged		The Netherlands
			Nido	Whole	Bottle		The Netherlands
30	02	01	Nido	Whole	Bottle	Dry	The Netherlands
			Amina	Whole	Repackaged		The Netherlands
31	02	01	Pura	Whole	Repackaged	Dry	The Netherlands
32	02	01	Amor	Whole	Repackaged	Dry	Irland
			Vivalait	Skimmed	Plastic bag		Togo
33	01	01	Nido	Skimmed	Plastic bag	Dry	South Africa
			Cowbell	Skimmed	Plastic bag		South Africa
			Chaya	Whole	Repackaged		The Netherlands
34	01	01	Vivalait	Skimmed	Repackaged	Dry	Togo
			Amor	Whole	Repackaged		Irland
			H£H	Skimmed	Plastic bag		Burkina Faso

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.

Table 5. Moisturecontent,pH and enterobacteria load onpowder 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

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

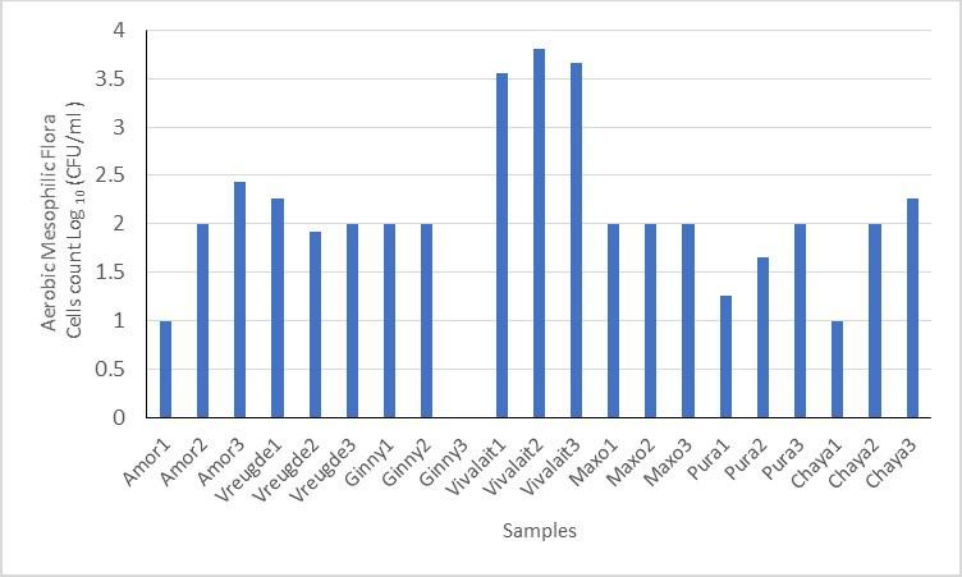

Figure 1. Loads of aerobic mesophilic flora in powder milk samples used for manufacturing dairy products in the city of Bobo-Dioulasso.

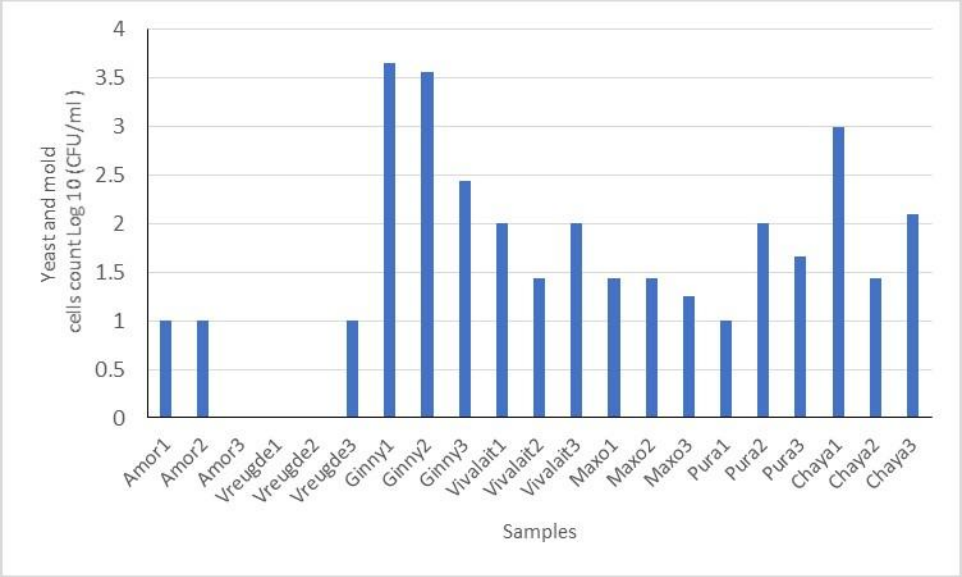

Figure 2. Loads yeast and mold in powder milk samples used for manufacturing dairy products in the city of Bobo-Dioulasso.

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)

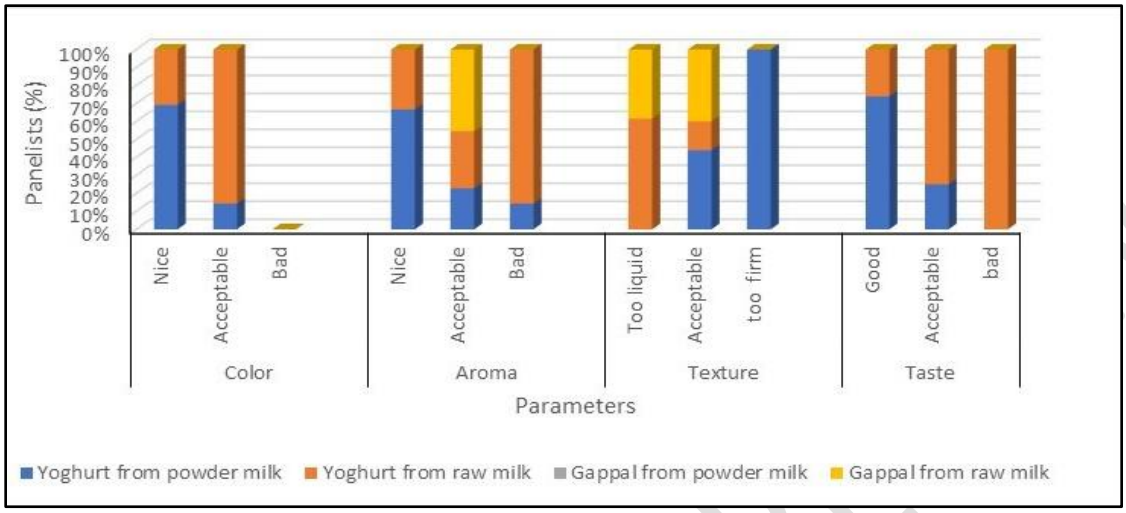

Figure 3. Sensorial appreciations (%) of colour, aroma, texture and taste of yoghurt and *gappal* locally manufactured from local raw milk and imported powder milk.

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 Fig. 5 and 7.

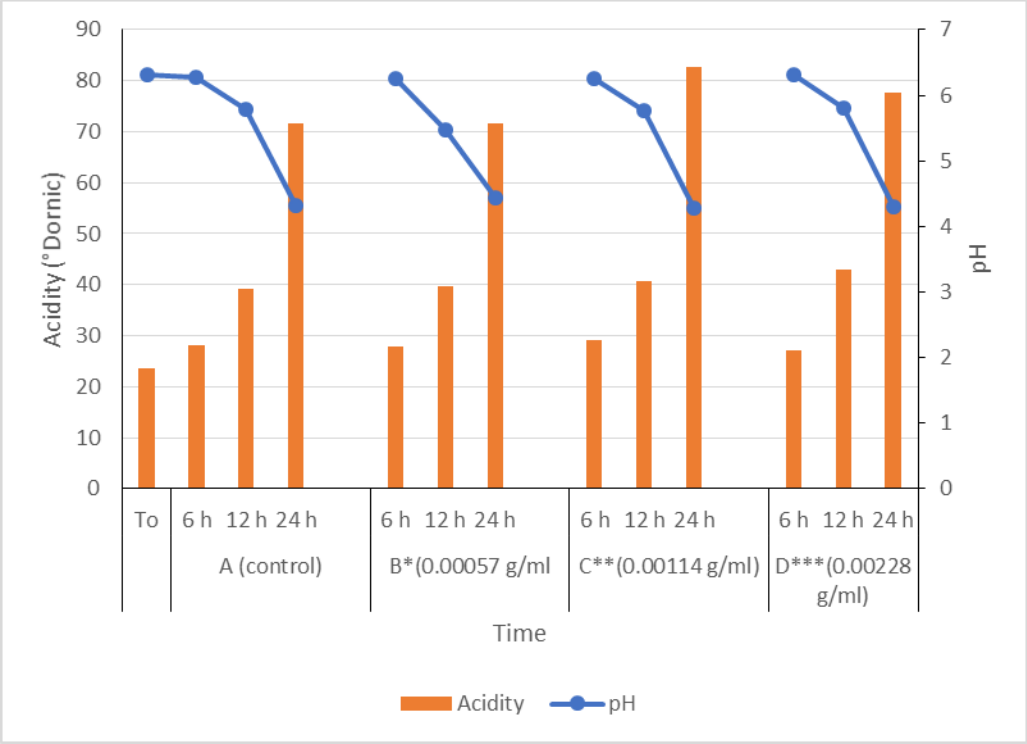

Figure 4. Evolution of pH and acidity versus time for different NaCl concentrations in raw milk.

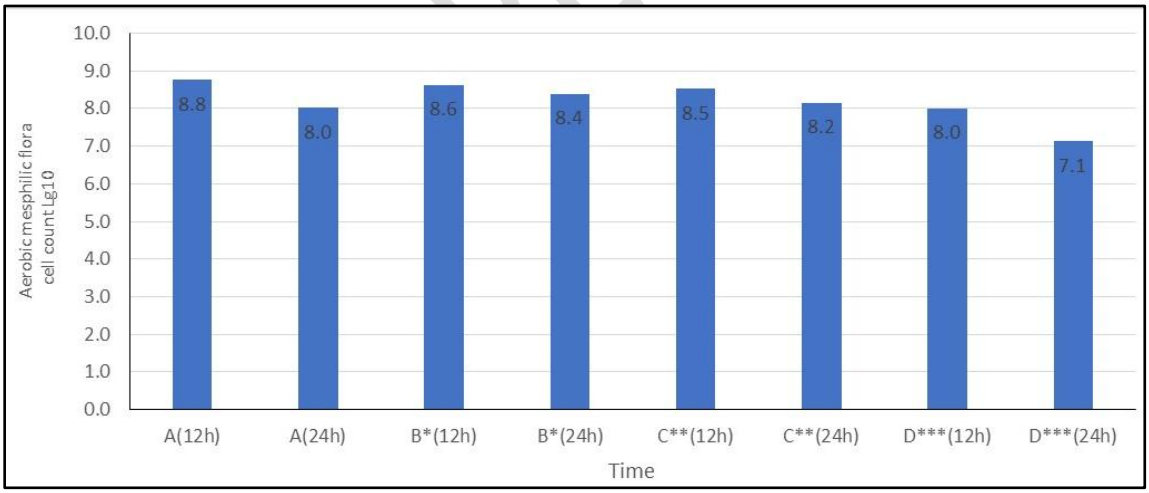

Figure 5. Evolution of aerobic mesophilic flora loads versus time for different NaCl concentrations in raw milk: A (0g/ml); B*(0,00057g/ml) ; C**(0,00114g/ml) ; D***(0,00228g/ml).

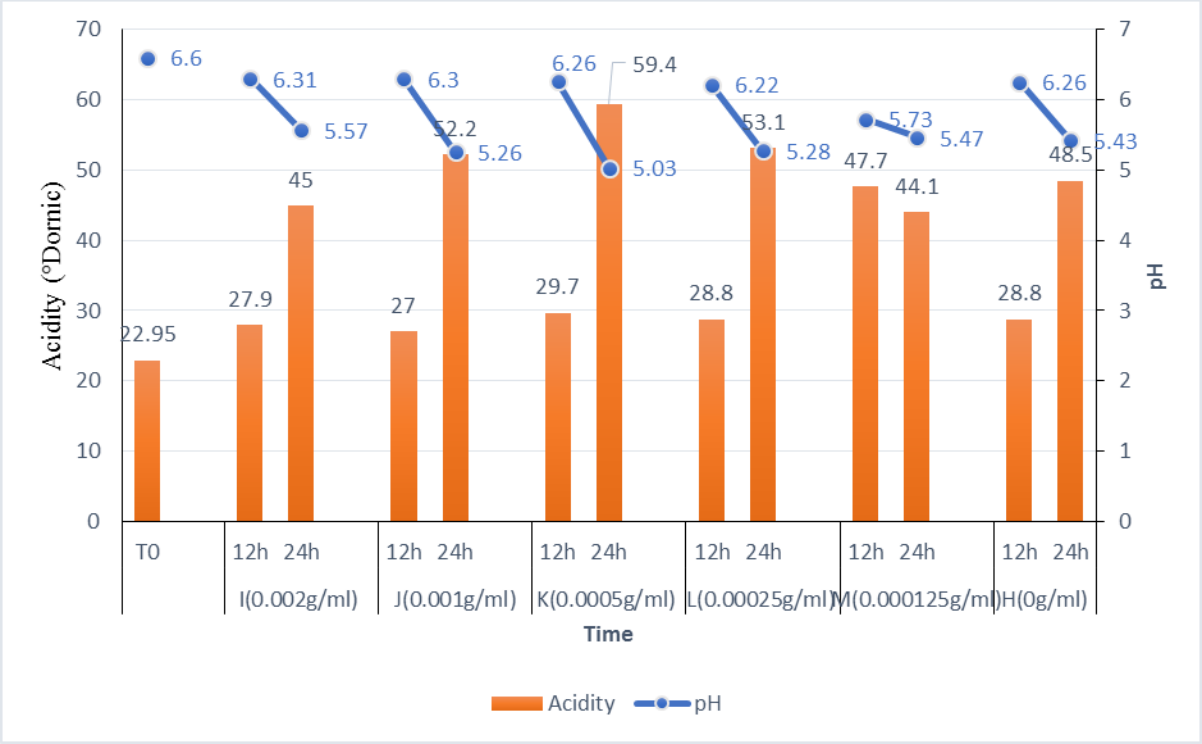

Figure 6. Evolution of pH and acidity versus time for different *toupaï* concentrations in raw milk.

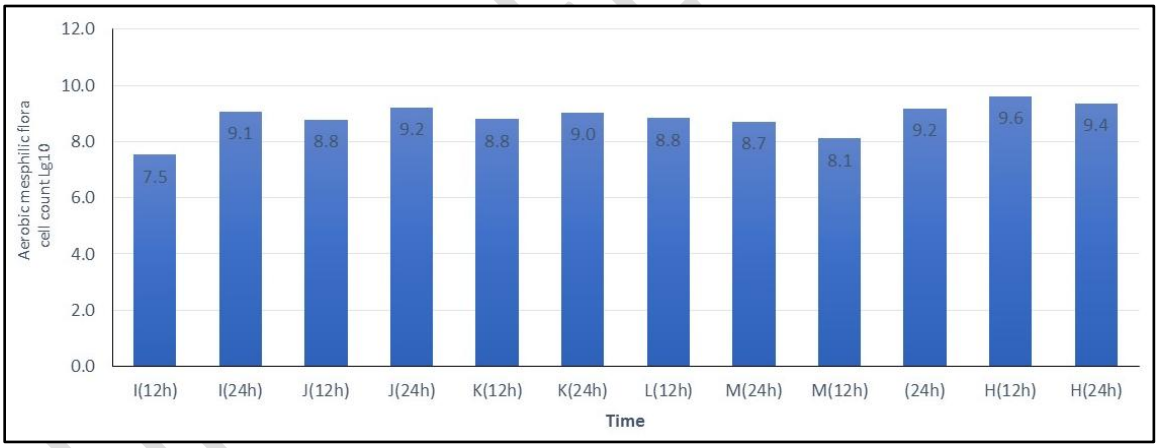

Figure 7. Evolution of aerobic mesophilic flora versus time for different *toupaï* concentrations in raw milk: H(0 g/ml); I(0,002g/ml) ; J(0,001g/ml) ; K(0,0005g/ml) ; L(0,00025g/ml) ; M(0,000125g/ml).

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. Dataalso

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.

5. Dataset validation

The assessment in laboratory of fraudulent practices was based on the reports from the survey.

Data availability

The underlying data, tables and figures, are stored at Mendeley Data repository

DOI:10.17632/wxf6ghwwrk.2

Link address: https://data.mendeley.com/datasets/wxf6ghwwrk/2

References

Bayili, G.R., Johansen, P., Nielsen, D.S., Sawadogo-Lingani, H., Ouedraogo, G.A., Diawara, B., Jespersen, L. 2019. Identification of the predominant microbiota during production of curdled milk, a spontaneously fermented milk product made in Burkina Faso. World Journal of Microbiology and Biotechnology 35, 100. https://doi.org/10.1007/s11274-019-2672-3.

Bayili, G.R., Konkobo-Yaméogo, C., Diarra, S. Diawara, B., Jespersen, L., Sawadogo-Lingani, H. 2023. Effect of fermentation process on hygiene and perceived quality of curdled milk, an ethnic milk product from Burkina Faso. Journal of Ethnic Foods 10, 17. https://doi.org/10.1186/s42779-023-00185-4

Broutin, C., Levard, L., Goudiaby, M-C. 2018. What commercial policies for promoting the "local milk" sector in West Africa? Paris, Gret, 100 p

Duteurtre, G., Vidal, A. 2018. The dairy sector in Bobo-Dioulasso. Final report. Study carried out at the request of Afdi, CIRAD Montpellier, 50p.

Corniaux, C. 2013. Study relating to the formulation of a detailed action program for the development of the milk sector within the UEMOA. Annex 2: Burkina Faso report. CIRAD. 28p.

FAO. 2016. Review of the livestock/meat & milk sectors and the policies that influence them in Burkina Faso. 57p. URL: http://www.fao.org/3/a-i5261f.pdf (Accessed: 13/11/2023).

ISO 4833:2003(E). 2003. Microbiology of Foods. Horizontal method for the enumeration of microorganisms; colony counting technique at 30°C.

ISO 7954:1988(E). 1988. General guidelines for the enumeration of yeasts and molds, colony counting techniques at 25°C.

Kemp, S.E., Hollowood, T., Hort, J. 2009. Sensory Evaluation A Practical Handbook. Wiley-Blackwell Publisher: United Kingdom. 208p.

French Standard NF V 08-060. 2009. Enumeration of thermotolerant coliforms by counting colonies obtained at 44°C.

Action Platform for Securing Pastoral Households (PASMEP). 2016. Local milk: advocacy to save a threatened sector in Burkina Faso (Advocacy document for actors in the milk sector in Burkina Faso). Ouagadougou, Burkina Faso. 16p.

Traore, S., Bayili, G.R., Sissao, M., Sangare, B., Millogo, V. 2022. Applicability of the 5M of the HACCP system in dairy processing units and effects on the hygienic quality of local dairy products in Burkina Faso . International Journal of Biological and Chemical Sciences 16(6): 2641-2657. ttps://dx.doi.org/10.4314/ijbcs.v16i6.15