Journal of Food Security, 2019, Vol. 7, No. 3, 80-89
Available online at http://pubs.sciepub.com/jfs/7/3/3
Published by Science and Education Publishing
DOI:10.12691/jfs-7-3-3

Evaluation of Food Safety Management in Artisanal and Semi-Industrial Dairies of Ouagadougou, Burkina Faso

Pauline Aissaioulè Millogo-Dah[1,3], Fulbert Nikièma[2], Hama Cissé[1], Asseto Somda[2], Abdou Azize W. Ouédraogo[2], Abel Tankoano[1,3], Namwin Siourimè Somda[1,3], Hagrétou Sawadogo-Lingani[3], Aly Savadogo[1,*]

[1]Laboratoire de Biochimie et Immunologie Appliquées, Université Joseph KI-ZERBO, Ouagadougou, Burkina Faso
[2]Direction du Contrôle des Aliments et de la Nutrition Appliquée, Laboratoire National de Santé Publique, Ouagadougou, Burkina Faso
[3]Département Technologies Alimentaires, Centre National de Recherche Scientifique et Technologique, Ouagadougou, Burkina Faso
*Corresponding author: alysavadogo@gmail.com

Received May 19, 2019; Revised June 27, 2019; Accepted July 21, 2019

Abstract This study was carried out to evaluate food safety management in 30 units of artisanal and semi-industrial dairies in Ouagadougou. A total of 257 samples from raw materials, production water, equipment washing water, rinsing water, hand surfaces, tables, utensils and finished products were collected all along the process, between February 2017 and November 2018. Microbiological analysis were realized according to standard methods described in the manual of microbiological analysis of AFNOR. The results showed a non-compliance of final products in 70% of dairies. 83.3% of the raw materials were of unsatisfying quality. The maximum of non-compliances was found at the labor force and method used levels. The surfaces and rinsing waters of the equipment were nonconforming in 91.1% and 76.7% of the dairies. They were also identified as a major source of contamination by microbiological contaminants. Production water and ferments were respectively 56.7% and 58.2% of the cases and was identified as a minor source of contamination. The low level of quality is related to the high load of total mesophilic aerobic flora and total coliforms. Quality monitoring in artisanal units focused on the mastering of washing methods, disinfection and manufacturing methods by government competent services is necessary to improve the quality of dairy products in Burkina Faso.

Keywords: *dairy products, hygiene, hazard, contamination, Burkina Faso*

Cite This Article: Pauline Aissaioulè Millogo-Dah, Fulbert Nikièma, Hama Cissé, Asseto Somda, Abdou Azize W. Ouédraogo, Abel Tankoano, Namwin Siourimè Somda, Hagrétou Sawadogo-Lingani, and Aly Savadogo, "Evaluation of Food Safety Management in Artisanal and Semi-industrial Dairies of Ouagadougou, Burkina Faso." *Journal of Food Security*, vol. 7, no. 3 (2019): 80-89. doi: 10.12691/jfs-7-3-3.

1. Introduction

Food is involved in the occurrence of many acute and chronic diseases worldwide [1]. These foods are contaminated by bacteria, viruses, parasites, toxins and chemicals [2]. Developing countries are the most affected by these diseases [3], where they are a major cause of death [4,5]. Food may be contaminated by a process of cross-contamination directly from a foodstuff or indirectly from equipment, utensils or a surface in contact with the food [6]. Pathogens can come from infected people handling food [7]. Lack of cleaning and sanitation is also a contributing factor to many outbreaks of foodborne illness [8].

Dairy products are foods with a high potential for microbial contamination [9,10]. About 7% of food-borne epidemic infectious diseases are caused by milk and dairy products [11]. This is due to the composition of milk-based foods which is a good environment for the development of pathogenic microorganisms [12] such as *Listeria monocytogenes*, *Salmonella* spp, *Mycobacterium* spp, *Yersinia* spp [13], *Brucella*, *Staphylococcus aureus*, enterobacteria, including *Escherichia coli* producing toxins [14]. In developing countries, this contamination is favored by the unsanitary conditions in which these products are processed [15].

Improving food safety therefore appears to be the outcome [16] of managing risks that could make food detrimental to the health of the consumer. It involves microbiologically the prevention of food against pathogenic microorganisms. Hazard Analysis and Critical Control Point (HACCP) is a prevention method that identifies, evaluates and controls potential risks at each stage of food processing [17].

In Burkina Faso, many studies have been conducted on the quality of dairy products manufactured generally [18,19,20] and specifically the fermented milk [21,22], yoghurt and pasteurized milk [23,24]. In most of the results, the microbiological quality of the finished products was unsatisfactory. The presence of microbiological hazards has been confirmed by the results of the studies of [20,25].

Some have suggested taking into account quality approaches in food processing [26]. However, the satisfactory quality of the finished products depends on mastering all the tangible and intangible factors that contribute to their achievement. However, no studies have assessed the level of influence of sources of microbiological hazards such as the raw material used, the dairy environment, the material, the method of work and the staff on the milk processing into by-products.

The purpose of this study is to assess the level of management of microbiological hazards along the entire dairy product processing chain of the artisanal and semi-industrial dairies in Ouagadougou.

2. Materials and Methods

2.1. Study Period and Sites

The study was conducted from February 2017 to November 2018 in thirty artisanal and semi-artisanal dairies of Ouagadougou, situated at 12°21′56″ north latitude and 1°32′01″ west longitude (Figure 1).

2.2. Diagnosis and Hazards Analysis

The diagnosis was carried out from an examination of each dairy, using an audit sheet based on the recommendations of Codex Alimentarius in 2011 and the Guide of Good Practices in Dairy Production in Burkina Faso in 2005. The hazards in the different processes were analyzed using the decision tree of the HACCP method, to determine the critical control points of processes diagrams. The sheet was subdivided into five distinct parts according to the method of Ishikawa. The number of non-compliances found in the dairies was totaled/Put together and considered/qualified as frequency of hazard's occurrence. The level of the risk was determined by the following formula (Figure 2):

Risk level= Probability x Severity x frequency.

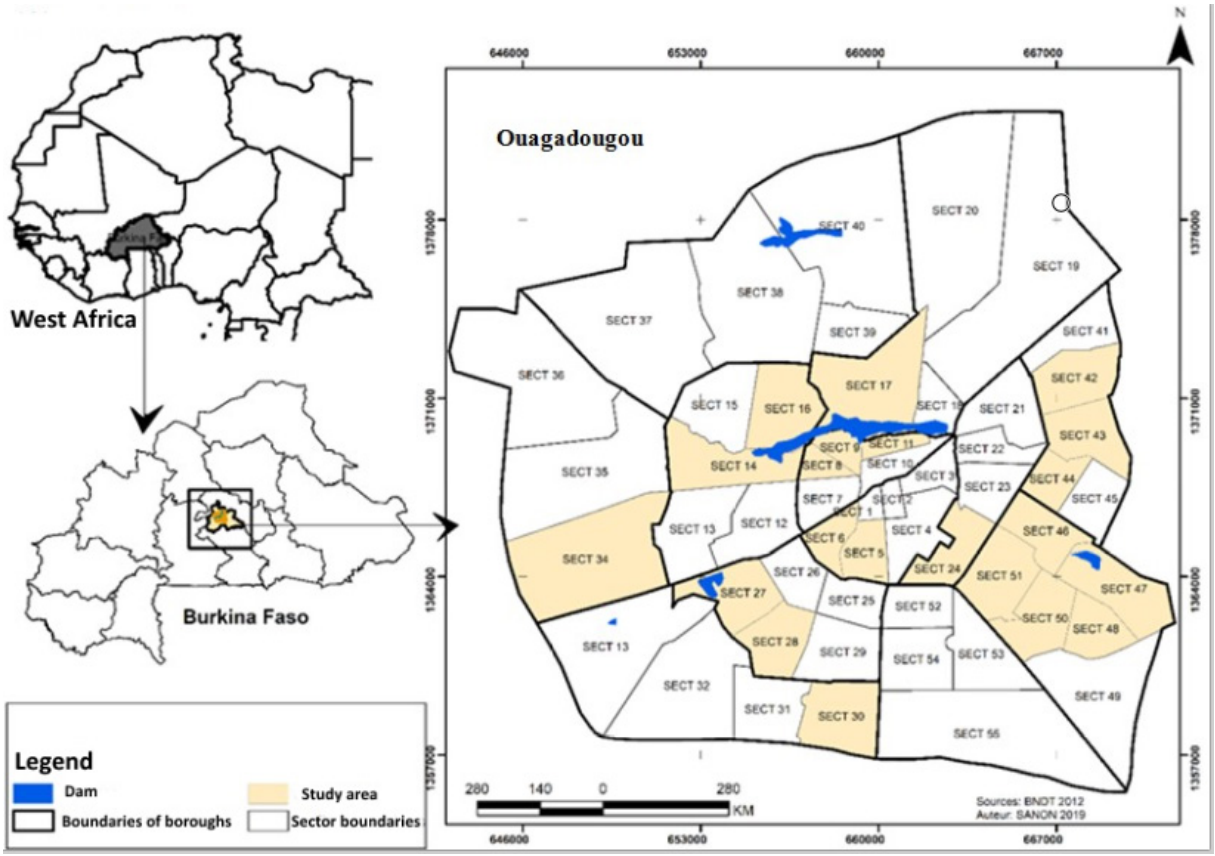


Figure 1. Study area

Probability					
	4	Moderate Risk	Important/Significant Risk	Critical Risk	Critical Risk
	3	Limited Risk	Moderate Risk	Important/Significant Risk	Critical Risk
	2	Limited Risk	Moderate Risk	Moderate Risk	Important/Significant Risk
	1	Limited Risk	Limited Risk	Limited Risk	Moderate Risk
		1	2	3	4
		Severity			

Figure 2. Risk assessment matrix

2.2. Sampling

A total of 257 samples were collected for microbiological analysis. The swabs were collected on 20 square centimeters of each surface [27]. Samples were taken from about thirty utensils, thirty tables and the hands of thirty dairy product handlers after cleaning [28]. Sterile swabs incorporated into five (5) ml sterile peptone water tubes were used for each surface.

Three types of water were collected in each dairy. The ninety collected samples were made up of water used for processing, the first soapy water for washing utensils, and the last rinse water for rinsing utensils.

Seventy-seven samples of raw material such raw milk and powdered milk, leaven used for yoghurt and processed products such steamed yoghurt, stirred yoghurt, pasteurized milk and cheese were collected and placed in a sterile jar.

All the samples were placed in a cooler and transported to the laboratory and stored in the refrigerator for analysis.

2.3. Microbiological Analyses

Samples were analyzed according to standard methods. The enumeration and research of the Total Mesophilic Aerobic Flora [29], *Staphylococcus aureus* [30], Total coliforms [31], Thermotolerant coliforms [32], *Escherichia coli* [33], *Salmonella* [34] were carried out according to the recommendations of AFNOR.

2.4. Statistical Analysis of Data

The data collected through the audit sheet were used to determine the risk factors.

The number of units forming a colony per surface area, per milliliter or per gramme was calculated and the hygienic quality of the samples were assessed using standards. The significance of any observed differences was determined by Chi² test. The statistical significance was set at $P<0.05$. The data were analyzed using SPSS (Statistical Package for Social Sciences) and Microsoft Excel 2000.

3. Result

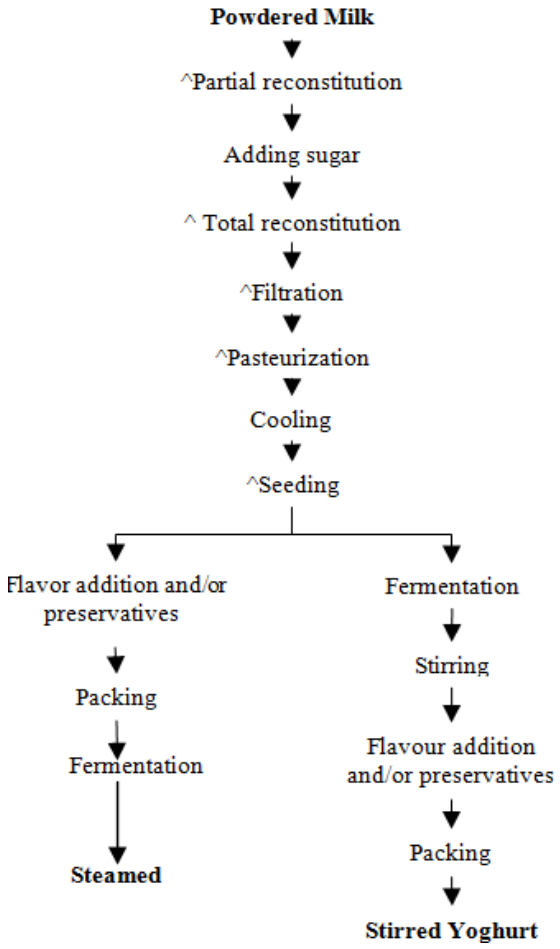
3.1 Management of the Dairy's Analysis

The results show that the majority of dairy managers are young with an age 26 and 45 years (60%). 26.67% are between 46 and 55 years old and 13.33% are between 46 and 65 years old. In terms of level of education, 13.33% have a non-formal education, 33.33% the level, 33.33% the secondary level and 20% the higher level. About 50% have less than 10 years of experience in dairy processing. Managers almost all hold the position of production manager (93.33%) and 90% have less than 10 employees.

About the quality management, only 20% of managers theoretically know the quality standards. However, no dairy has an internal quality manager. The health of employees is not regularly monitored (0%) and only 3.33% carry out an annual medical examination. Only 56.67% record the data relating to their activity and these documents essentially concern the registration of sales.

3.2. Existing Manufacturing Processes

The processed products derived from the study are the pasteurized milk, yoghurt and cheese. At 90% the majority of the dairies are artisanal while only 10% are semi-industrial. Figure 3 and Figure 4 summarize the different stages of the manufacturing processes depending on the raw material. Mainly, 63.4% of the stakeholders use powdered milk for manufacturing while 37.6% use raw milk (Figure 5).



Keys: ^ = treatment methods different from one dairy to another;

Figure 3. Diagram of steamed and stirred yoghurt form powder milk

The majority of the dairies are artisanal (90%) and about 63% of them process daily less than 50 liters of milk. The production frequency per week is also slow (Table 1).

Table 1. Type and processing level

Variables	Modalities and frequency
Type of processing	Artisanal (90%) Semi industrial (10%)
Daily processing capacity	1 - 50 L (63.33%) 50 - 100 L (10%) 100 - 150L (6.67%) 150 - 200L (6.67%) Above 200L (13.33%)
Processing frequency	1 - 3 days (23.33%) 4 - 6 days (60%) Daily (16.67)

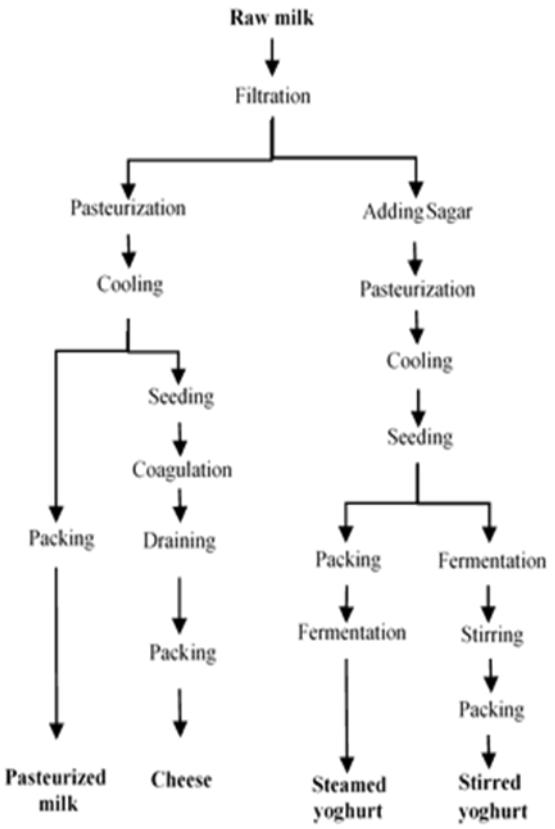


Figure 4. Diagram of steamed and stirred yoghurt, pasteurized milk and cheese from raw milk

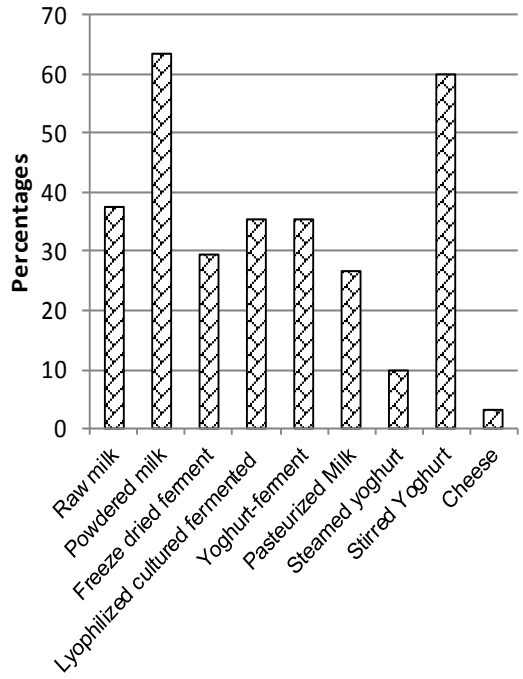


Figure 5. Distribution of raw materials and finished products

3.3. Manufacturing Processes Analysis

Many differences in manufacturing processes were observed among dairies. They are mainly based on the presence or absence of filtration, pasteurization, seeding and the addition of preservatives (Table 2).

Table 2. Deference between processes

Process based on raw material	Process stages	Finished products	Dairies (%)
Process with powdered milk	a, b, g, h, i, j, m	Stirred yoghurt	23.4
	a, b, f, g, h, i, j, m	Stirred yoghurt	13.4
	a, b, c, d1, e, f, g, h, i, j, m	Stirred yoghurt	10.0
	a, b, c, d1, e, f, g, j, m	Stirred yoghurt	10.0
	a, b, c, d, e, f, h, i, m, g	Steamed yoghurt	3.3
	a, b, f, h, i, m, g	Steamed yoghurt	3.3
Process with raw milk	c, d_1, e, m	Pasteurized milk	16.7
	c, d_2, e, m	Pasteurized milk	10.0
	c, d_1, e, b, f, m, g	Steamed yoghurt	3.3
	c, d_1, e, b, f, g, j, m	Stirred yoghurt	3.3
	c, d, e, f, g, k, m	Cheese	3.3

a = milk reconstitution; **b** = sugar addition; **c** = filtration; **d_1** = pasteurization; **d_2** = Heating; **e** = cooling; **f** = seeding; **g** = fermentation; **h** = flavor addition; **i** = preservative addition; **j** = stirring, **k** = draining; **m** = packing.

96.6% of the actors process milk by 63.4% of dairies, using a container and a hand whisk. Dairies milk reconstitution step are 100% manual. Sugar is added before filtration, or after filtration or even after fermentation. Some actors perform filtration after pasteurization to remove the fat layer. Sometimes this is done after fermentation to ensure a uniform texture of the yogurt. This step is totally manual and is done in contact with a sieve or fabric and therefore with the milk. 50% of the actors carry out pasteurization. It is done with a double pan for most of the actors. 10% of the actors estimate that they have pasteurized their milk by heating it to a temperature of about 50°C. 40% never pasteurize their milk. After pasteurization, pots containing hot milk are closed and placed in basins containing water. In dairies carrying out pasteurization, the milk cooling process, which is done by renewing the water, is monitored with a thermometer until about 45 ° C. Any dairy uses ice blocks to speed up milk cooling. Thus, the cooling time varies from one dairy to another and is influenced by the ambient temperature. The thermometer is washed with ordinary cleaning soap and rinsed with water in almost all dairies (73.33%).

Most of the ferment users use yoghurt as ferment to make yoghurt and cheese. The yoghurt is prepared from either a freeze-dried ferment previously prepared in a small quantity of milk used and distributed into small portions, or taken from previous production or purchased on the market. Flavors are generally contained in 7 cL vials or 5g bags that are used at one time. On the other hand, the preservative granules used are contained in bags. The milk ferment while at rest, in closed containers for a minimum of 3 hours to 20 hours depending on the production units. However, 40% of dairies obtain their products from spontaneous fermentation. In 20% of the units, the container with the reconstituted milk remains opened during all the time of fermentation which is usually at night, under fans in some cases. Dairies need an average of 4 to 5 hours to obtain yogurt. The minimum time for fermentation in dairies is 3 hours, the maximum is 20 hours with an average of 8.46 hours.

Stirring is a stage where the possibility of contamination is high due to the posture of the operators. Almost all units have whips that are not sized for the container containing

the yogurt to be stirred. As these whips are shorter, operators lower themselves considerably with the risk of emitting spittle over the yogurt, or droplets of sweat falling into the yogurt. This step is a critical point in the production of yogurt.

Draining is completely manual. The only unit that produce cheese uses a handcrafted wooden pressure that is not disinfected before the beginning of the activity.

Pasteurized milk is packaged when the temperature of the milk is approximately between 42 to 55°C depending on the units. The process is short and fast. Contrarily, for all other products, packaging requires time and manual action. None of the dairies disinfect the equipment during the study.

3.4. Assessment of Sources of Risk

Table 3, show the results of the data collected during the diagnosis according to the Ishikawa diagram for the determination of the degree of contamination according the origin.

Table 3. Non-compliances level in dairies

Focus Aspects	Min	Max	Mean
Environment	0	36	22
Material	0	18	7
Raw material	0	24	8
Labour-force	18	90	66
Method	36	144	97

3.4.1. Environment

The study reveals that the average nonconformities in the environment of dairies compared to the requirements of the audit sheet is twenty-two (22) (Table 3). The external environment is not taken into account in the general hygiene of dairies (Figure 6). 50% of processing site are in an isolated courtyard, and 50% in an inhabited courtyard. Insalubrity is an important risk factor that can lead to product contamination during processing throughout dust. 50% of dairies are either insalubrious or inhabited by families with animals. Contamination may occur because most of the visitors don't use appropriate Personal Protective Equipment.

Figure 6. Trash in front of a dairy (1), Overflowing garbage cans in a yard (2), stools behind a refrigerator (3), Disorder in the storage of material (4)

3.4.2. Material

The diagnosis of hygienic equipment is satisfactory in the general. The average non-compliances observed on dairies' equipment is the lowest (7). Some non-compliance was detected due to the inadequacy of some equipment (wood) or sieve which was not disinfectable.

In general, the equipment used is made of stainless steel, aluminum, iron, nylon, plastic, washable and disinfectable, but some wooden utensil is found in 3 dairies (Figure 7).

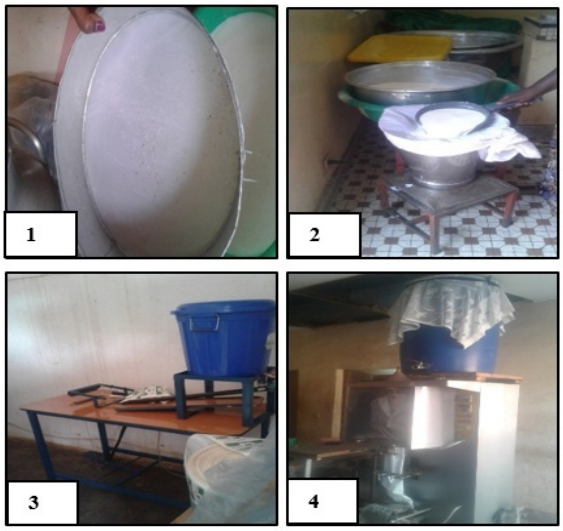


Figure 7. Filtration sieve after pasteurization (1), Pasteurization pan and pasteurized milk filtration fabric (2), Local manufacturing packaging machine (3), Foreign manufacturing packaging machine (4)

3.4.3. Raw Material

In No dairy has microbiological quality requirements for receiving raw materials. They haven't any internal capacity to control their own raw materials quality. In most dairies, powdered milk is packaged in bags. In the site, the received unpasteurized milk is processed on the spot. The non-compliances noted in the management of the material were the storage conditions for powdered milk and the lack of testing and reception space for unpasteurized milk (Figure 8).

Figure 8. Dog and children near the delivered milk (1), Exposed raw milk (2), Powdered milk on the floor (3), Unreadable sugar label (4)

3.4.4. Labor Force

The Coefficient note's average number of non-compliance at the diagnostic level is unsatisfactory given that operators are involved and handle products throughout the chain.

Dairies are owned by low-educated people aged from 26 to 65 years, and 53.33% of the owners have less than 10 years of experience. 90% of the dairies have less than 10 employees. Many non-compliances such as lack of proper work attire, jewelry wearing, no or bad handwashing, ignorance of milk and dairy products processing methods, no or bad use of disinfectants were pointed out (Figure 9). 96.7% of employees do not use personal protective equipment (PPI) when accessing the unit.

Figure 9. Bracelet on the operator's arm and non-compliant work attire (1), Non-compliant work attire and non-compliance with hygiene rules (2), Yoghurt packaging on the ground and without proper attire (3), Operator with non-compliant work attire and covered with dust (4)

Employees do have compliant clothing at 36.67% and do hand washing at 66.67%, but do not disinfect hands at 86.67%. (Table 4) This could lead to contamination issues.

Table 4. Dairy units' owners and employee's knowledge on food safety

Variables	Modalities and frequency
Training on food hygiene of the Owner or manager	Yes (63.33%) No (36.67%)
Employees trained on food hygiene	Yes (66.67%) No (33.33%)
Trainers of the employees on food hygiene	By manager's (75%) Professional training (25%)
Compliant staff clothing	Yes (36.67%) No (63.33%)
Clean clothes	Yes (86.67%) No (13.33%)
Staff hand washing	Yes (66.67%) No (33.33%)
Hands disinfection	Yes (13.33%) No (86.67%)

3.4.5. Method

90% of the dairy units are artisanal with a low production capacity. The diagnosis of the method resulted in the highest average. Indeed, the basic principles of hygiene are not known or respected. Dairies units' owners don't have required training on food hygiene, they also have poor knowledge on food safety standards. 53.33% of the owners have less than 10 years of experience.

A third of the units' employees are not trained on food hygiene and those who were little trained received it in an informal way from the owners, who happened to have a poor knowledge on food safety (Table 5).

Table 5. Material cleaning methods before processing

Variables	Frequency
Cleaning of the material before processing	Rinsing with water (43.33%) Washing (33.33%) Disinfection (13.33%) Washing and disinfection (10%)

Employee's ignorance of the precautions before and during processing was detected through the assessment of non-conformities (Figure 10).

Figure 10. Non-compliant milk filtration (1), Risk posture during milk reconstitution (2), Risk posture during yogurt mixing (3), Risk during yogurt packaging (3)

3.5. General Appreciation of Hygienic Conditions

The general assessment of the 257 samples collected in the dairies gave the following results (Figure 11 and Table 6).

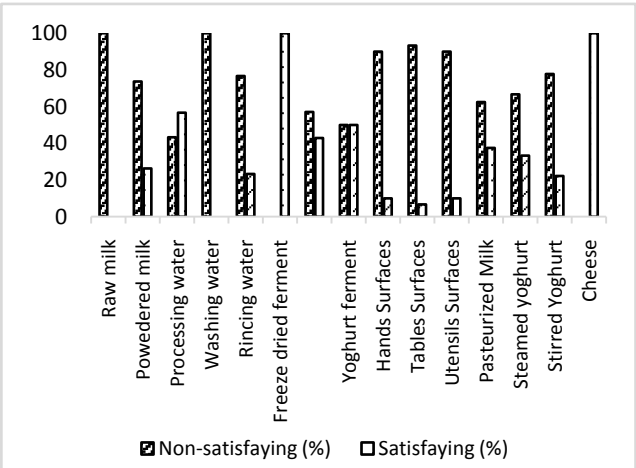


Figure 11. General appreciation of samples

Table 6. Microbiological quality of samples

Sample	Variable	*Staphylococcus aureus*	TAMF	Total coliforms	Thermotolerants coliforms	*Escherichia coli*	*Salmonella*	Global appreciation
Washing water	Not satisfactory	13.3	93.3	73.3	60	3.3	16.7	100
	Satisfactory	86.7	6.7	26.7	40	96.7	83.3	0
Rinsing water	Not satisfactory	6.7	76.7	50	46.7	0	0	76.7
	Satisfactory	93.3	23.3	50	53.3	100	100	23.3
Hands surface	Not satisfactory	23.3	90	46.7	13.3	3.3	0	90
	Satisfactory	76.7	10	53.3	86.7	96.7	100	10
Tables surface	Not satisfactory	3.3	93.3	66.7	30.0	3.3	0	93.3
	Satisfactory	96.7	6.7	33.3	70.0	96.7	100	6.7
Utensils surface	Not satisfactory	0	90	43.3	13.3	3.3	0	90
	Satisfactory	100	10	56.7	86.7	96.7	100	10
Milk	Not satisfactory	30	30	36.7	23.3	6.7	0	83.3
	Acceptable	0	3.3	3.3	10	0	0	0
	Satisfactory	70	66.7	60	66.7	93.3	100	16.7
Processing water	Not satisfactory	6.7	43.3	16.7	16.7	3.3	3.3	43.3
	Satisfactory	93.3	56.7	83.3	83.3	96.7	96.7	56.7
Ferments	Not satisfactory	5.9	NA	29.4	23.5	0	0	41.2
	Acceptable	5.9	NA	0	0	0	0	0
	Satisfactory	88.2	NA	70.6	76.5	100	100	58.8
Finished products	Not satisfactory	23.3	6.7	63.3	50	0	0	70
	Acceptable	10	73.3	0	0	0	0	0
	Satisfactory	66.7	20	36.7	50	100	100	30

3.5.1. Wash and Rinse Water

The water used for washing and rinsing the equipment is of unsatisfactory microbiological quality (Table 6). The results of analyzes showed that no wash water sample was satisfactory (0%). Virtually all washings were unsatisfactory relative to total mesophilic aerobic flora (93.3%), and the majority unsatisfactory compared to total coliforms (73.3%) and thermotolerant coliforms (60%). *E. coli* and *Salmonella* were not found in all the rinsing. The general assessment of microbiological quality is satisfactory in only 23.3% of dairies. 50% of rinsing water was satisfactory compared to the total coliforms and 53.3% with respect to the thermotolerant coliforms.

3.5.2. Surfaces

Overall, more than 90% of hand surfaces, utensils and tables are unsatisfactory (Figure 12).

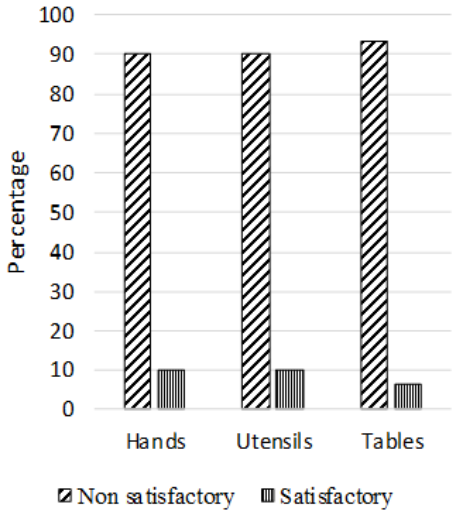


Figure 12. General assessment by type of surface

The results of microbiological analyzes (Table 6) revealed a total absence of salmonella from the samples of the surfaces of the hands, tables and utensils. *E. coli* were counted in a few dairies (3.3%), thermotolerant coliforms on hands and utensils (13.3%) and on tables (30%), total coliforms (43.3 to 66.7%).

3.5.3. Raw materials

Before the pasteurization stage

The general assessment of the raw materials used prior to the pasteurization stage is summarized in Figure 13. These are powdered milk, raw milk and produced water used for the reconstitution of powdered milk, collected in the dairies. The results showed that microbiological quality was unsatisfactory for 100% of samples of raw powdered milk, 73.7% of powdered milk and 43.3% of production water.

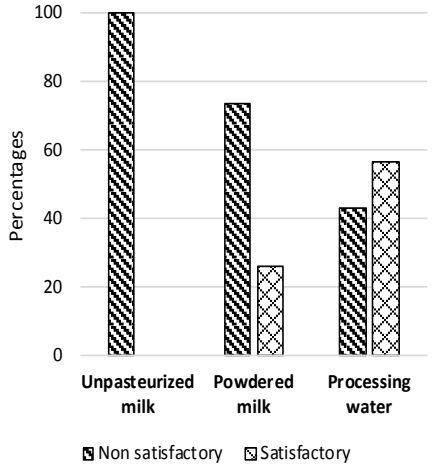


Figure 13. General appraisal by type of raw material

In total, only 16.7% of the dairies had satisfactory samples for the raw milk and 56.7% for the raw material water.

After the pasteurization stage

The general microbiological quality of ferments used is satisfactory for 58.8% of the samples (Table 6). The microbiological quality of all freeze-dried ferments is satisfactory (Figure 14). The unsatisfactory quality of the other yoghurt ferments made in the unit or bought on the market reveals the risk that they represent for the manufacture of dairy products, especially since most of the milk is not pasteurized.

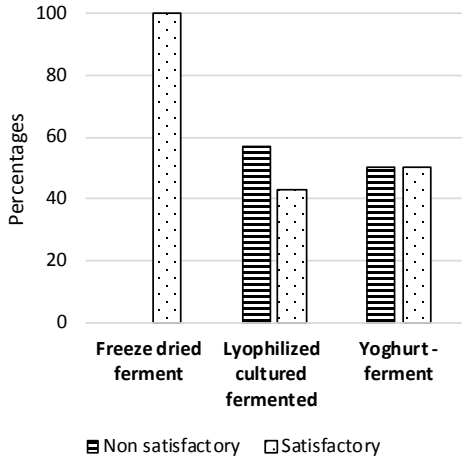


Figure 14. General assessment by type of ferment

3.5.4. Finished Products

At the end of manufacturing, 30% of the finished product samples were of satisfactory microbiological quality (Table 6). *E. coli* and *Salmonella* were absent in all finished products consisting of pasteurized milk, parboiled yogurt, stirred yogurt and cheese. In general, pasteurized milk and yogurts have a satisfaction rate of between 20 and 40 % (Figure 15).

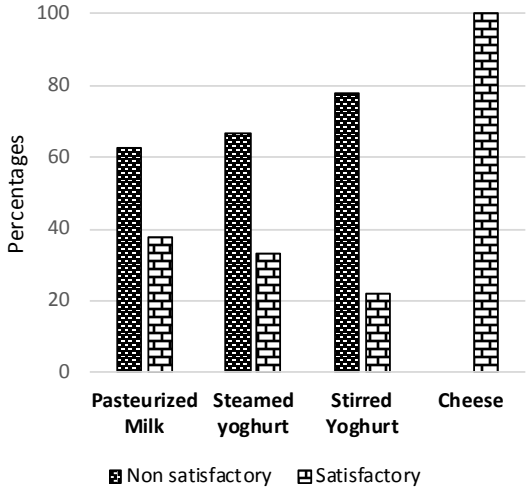


Figure 15. General assessment by type of finished product

3.5.5. Correlation between General Assessment and Identified Microorganisms

Table 7 shows that there was positive correlation between general appreciation and TMAF (rs = 0.714; P<0.003), as well as general appreciation and total coliforms (rs = 0.742; P = 0.002). The poor quality of the samples depends on the total coliform load and total flora. This indicates a poor general hygiene in the products processing

Table 7. Correlation between general assessment and identified microorganisms

Level	Spearman's rho	P
General interpretation – TMAF	0.714	0.003
General interpretation – TC	0.742	0.002

TMAF=Total Mesophilic Aerobic Flora, TC= Total Coliforms.

4. Discussion

The diversity of processes is due to the fact that the manufacturing units' managers have learned to process milk informally or from relatives. About 50% of them receive training without having a real effect on some of them habits change.

Milking with dirty hands, transportation and sale without cold chain and mostly at room temperature will lead to a milk of questionable hygienic quality [35]. During processing, manual operations promote contamination when the hygienic status of the hands is doubtful. However, pasteurization eliminates pathogenic microorganisms [36].

Inadequate washing of the equipments during milk reconstitution, bad posture of the operator and non-potable water are potential sources of microbial contamination of reconstituted milk. Water is one of the main sources of potential food contamination in the artisanal context. It is either of poor quality at its origin or because it was subsequently contaminated and inadequately used [37]. The step is not critical when it is followed by pasteurization. It becomes critical for manufacturing processes that omit pasteurization.

The step of adding sugar varies according to the manufacturers. Microorganisms are not listed as sugar contaminants in the Codex Standard for Sugars [38]. Dry sugar is a product containing very little water with a water activity (a_w) between 0.2 and 0.3. These values are well below the limit of development of microorganisms (0.6 to 0.7). For this reason, dry sugar is considered to be a microbiologically safe product that does not require precautions other than Good Manufacturing Practices (GMP) and adequate storage [39,40].

It can help to introduce microorganisms into milk or milk products if it has been handled with dirty hands. The step will only be critical in the case where pasteurization is not carried out and if the addition is made after fermentation, i.e. for at least 50% of the actors.

The purpose of filtration before pasteurization is to remove solid hazards such as hair, sand grains and other impurities. The sieve or fabric, even after washing, if not disinfected, may still containing microorganisms due to the meshes and walls that are difficult to access. Poorly washed or disinfected hands can also contaminate the product. The step is not critical because it should only take place before pasteurization.

Most pathogenic microorganisms can be eliminated or reduced to safety during pasteurization operation [41]. When the thermometer used is poorly washed, poorly disinfected or not disinfected it may lead to contamination of pasteurized milk. The actors in the processing of dairy products do not dry their hands after washing or rinsing

(90%). Water droplets from hands that could be full of bacteria can also help to introduce microorganisms into the product. No subsequent operation can reduce or eliminate contamination at this stage. This operation is a critical point.

The seeding stage is a critical point. A ferment made without respect of hygiene rules is contaminated and so is the derived dairy product.

Addition of flavors and preservatives. Contamination is low and can potentially come from the containers used to dissolve the granules. The step is not bacteriologically critical. However, the addition of preservatives is not allowed in fermented milks that have not undergone heat treatment after fermentation [42].

Contamination is normally very low at this stage of fermentation or coagulation. In this case of artisanal dairies, airborne microorganisms can contaminate milk for an extended period of time. This technique could be an imitation of the traditional process of obtaining *féné*, a traditional dairy product. It is the rest of the unsold milk that is stored in buckets not covered at the market and left to ferment. Health risks are high [42]. This step would be critical for these specific units. Fermentation time plays an important role to the microbiological quality of the product.

Overtime stirring stage is a risk factor for the multiplication of pathogenic microorganisms. More this time is getting long, high will be the microbial load, leading so to the deterioration of final product quality. Stirring is a stage where the possibility of contamination is high due to the posture of the operators. Almost all units have whips that are not sized for the container containing the yogurt to be stirred. As these whips are shorter, operators lower themselves considerably with the risk of emitting spittle over the yogurt, or droplets of sweat falling into the yogurt. This step is a critical point in the production of yogurt.

During draining, the equipment and the operator's hands can be a source of contamination for the product. This step is a high source of microbial contamination risk and also a critical point because there is no subsequent step to eliminate pathogenic microorganisms.

Packing process is short and fast. However, even if the bactericidal effect of such treatment is effective, several risk factors persist such as used packaging that is not sterilized and material that is cleaned in a rudimentary manner [31]. The hygienic status of existing filling machines can be considered doubtful regarding the washing method used. For the manufacturing processes of steamed yoghurt, stirred yoghurt and cheese, this step is a critical point.

5. Conclusion

The analysis of the bacteriological quality of the final products has shown that the risks of contamination or multiplication are numerous in the dairy production chain. The sources of risk are primarily the surfaces of hands, utensils and tables. This is due to inefficient washing and lack of disinfection.

The operations are manual. Thus, labor force plays a vital role in contamination. The improvement of the quality of dairy products can only be achieved through the control, implementation and control of washing and disinfection methods of pasteurization. Milk is a perfect environment for the majority of microbiological contaminants. The risk that dairy products pose to consumers, in majority for children, requires a suitable framework for dairy product handlers.

Acknowledgements

Authors would like to thank all the responsible of the dairies for their collaboration and open mind to share their realities. Their also thank the QCT and LaBIA teams of the University Joseph KI-ZERBO for their contribution in this study.

Statement of Competing Interests

The authors have no competing interest in relation to their work.

References

[1] FAO et OMS. "Fardeau que représentent les maladies d'origine alimentaire et effets positifs de l'investissement dans la sécurité sanitaire des aliments", 2018a.

[2] FAO et OMS. "L'avenir de la sécurité sanitaire des aliments", 2018b.

[3] WHO., (Word Health Organization), 2015. WHO global strategy for food safety safer food for better health. World Health Organization, Geneva Sitzerland ISBN 924 154574 7.

[4] WHO, (Word Health Organization), 2002a. WHO global strategy for food safety safer food for better health. World Health Organization, Geneva Sitzerland ISBN 924 154574 7.

[5] WHO., (Word Health Organization), 2002b. Food safety and foodborne illness. Fact Sheet, n°237, 7p.

[6] Alum E. A., Urom S. M. O. C. and Ben C. M. A., "Microbiological Contamination Of Food: The Mechanisms, Impacts And Prevention", *International Journal Of Scientific & Technology Research*, 5 (03): 2277-8616, 2016.

[7] Hedberg C.W., MacDonald K.L. and Osterholm M.T., "Changing epidemiology of food-borne disease: A Minnesota perspective", *Clinical Infectious Diseases*. 18: 671-672, 1994.

[8] Podolak R., Enache E., Stone W., Black D. G., and Elliott P. H., "Sources and Risk Factors for Contamination, Survival, Persistence, and Heat Resistance of Salmonella in Low-Moisture Foods", *Journal of Food Protection*, 73: 1919-1936, 2010.

[9] Aaku E. N., Collison E. K., Gashe B. A. and Mpuchane S., "Microbiological quality of milk from two processing plants in Gaborone Botswana", *Food Control*, 15: 181-186, 2004.

[10] Chye, F.Y., Abdullah, A. and Ayob, M.K., "Bacteriological quality and safety of raw milk in Malaysia", *Food Microbiology*, 21: 535-541, 2004.

[11] Cerf O. "Risques bactériens liés aux produits laitiers", Revue Française des Laboratoires. N ° 348, 2002.

[12] CAC/RCP 57-2004. Code d'usages en matière d'hygiène Pour le lait et les produits laitiers.

[13] Farat Laurene. "Produits laitiers et santé". Diplôme d'etat de docteur en pharmacie. Université Claude Bernard - Lyon 1. 2014.

[14] Brisabois A., Lafarge V., Brouillaud A., de Buyser M. L., Collette C., Garin-Bastuji B and Thorel M.-F. "Les germes pathogènes dans le lait et les produits laitiers: situation en France et en Europe", *Revue scientifique et technique te l'Office international des Epizooties*, 16 (1): 452-471, 2018.

[15] Mogessie A., "Effect of curd-cooking temperatures on the microbiological quality of ayib, a traditional Ethiopian cottage cheese", *World Journal of Microbiology and Biotechnology*, 6: 159-162, 1990.

[16] OMS, 2007. Sécurité sanitaire des aliments et santé : une stratégie pour la région africaine de l'OMS.

[17] Ropkins, K. and Beck, A., "Evaluation of worldwide approaches in the use of HACCP to control food safety", *Trends in Food Science & Tecnology*, 11: 10-21, 2000.

[18] Tankoano A., Kaboré D., Savadogo A., Soma A., Fanou-Fogny N., Compaore-Sereme D., Hounhouigan J. D. and Sawadogo-Lingani H., "Evaluation of microbiological quality of raw milk, sourmilk and artisanal yoghurt from Ouagadougou, Burkina Faso", *African Journal of Microbiology Research*, 10 (16): 535-541, 2016.

[19] Bagré T.S., Samandoulougou S., Traoré M., Illy D., Bsadjo Tchamba G., Bawa-Ibrahim H., Bouda S. C., Traoré A. S. and Barro N. "Détection biologique des résidus d'antibiotiques dans le lait et produits laitiers de vache consommés à Ouagadougou, Burkina Faso", *Journal of Applied Biosciences*, 87: 8105-8112, 2015.

[20] Bagré, T. S. "Evaluation de la contamination des produits laitiers consommés par des résidus d'antibiotiques, des pathovars de Escherichia coli et Salmonella enterica au Burkina Faso". Thèse de doctorat unique. Université de Ouagadougou, 177p, 2015.

[21] Savadogo A. and Alfred S. Traoré, 2011. La flore microbienne et les propriétés fonctionnelles des yaourts et laits fermentés. *International Journal of Biological and Chemical Sciences*, 5(5): 2057-2075.

[22] Millogo V., Svennersten Sjaunja K., Ouédraogo G.A. and Agenäs S. "Raw milk hygiene at farms, processing units and local markets in Burkina Faso", *Food Control*, 21: 1070-1074, 2010.

[23] Sissao M., Millogo V and Ouédraogo G. A. "Composition chimique et qualité bactériologique des laits crus et pasteurisés au Burkina Faso". *Afrique Science*, 11(1): 142-154, 2015.

[24] Didnang Koye C., Millogo V., Mbaindingatoloum Molele F. and Ouedraogo G. A., "Evaluation de la qualité nutritive des laits pasteurisés et des yaourts fabriqués au Burkina Faso", *Afrique Science*, 11(1) : 155-166, 2015.

[25] Millogo, V., Sissao, M., & Ouedraogo, G. A. Qualité nutritionnelle et bactériologique des échantillons de quelques produits laitiers locaux de la chaîne de production au Burkina Faso. *International Journal of Biological and Chemical Sciences*, 12(1): 244-252, 2018.

[26] Barro N., Bello A. R., Itsiembou Y., Savadogo A., Ouattara C. A. T., Nikiéma A. P., De Souza C. and Traoré A. S., "Street-vended food improvement: contamination mechanisms and application of food safety objective strategy: critical review", *Pakistan Journal of Nutrition*, 6 (1) :1-10, 2007.

[27] Guyader, P., Amgar, A., Coignard, M., "*La désinfection: la vérification et la validation de l'efficacité des opérations de désinfection*", In: Bourgeois, C.M., Mescle, J.F., Zucca, J., "Microbiologie alimentaire-Tome1: aspect microbiologique de la sécurité et de la qualité des aliments". Paris: Lavoisier Tec & Doc, In *Sciences techniques et agroalimentaires*, 451-455, 1996.

[28] Institut National de l'Hygiène (INH), "Manuel de prélèvement santé environnement", 67p, 2015.

[29] AFNOR NF 4833, Microbiology of food and animal feeding stuffs – Horizontal method for the enumeration of microorganisms – Colony-count technique at 30°C., 2005.

[30] AFNOR NF V 08-057, Microbiologie des aliments – Méthode horizontale pour le dénombrement des staphylocoques à coagulase positive (*Staphylococcus* et autres espèces), 1999.

[31] AFNOR NF 08-050, Microbiology of food and animal feeding stuffs – Horizontal method for the enumeration of coliforms – Colony-count technique, 2006.

[32] AFNOR NF V 08-060. "Microbiologie des aliments - Dénombrement des coliformes thermotolérants par comptage des colonies obtenues à 44 °C", 2009.

[33] AFNOR NF V 08-017, Directives générales pour le dénombrement des coliforms fécaux et d'Eschérichia coli, 1980.

[34] AFNOR V 08-052, Microbiology of food and animal feeding stuffs – Horizontal method for the detection of Salmonella spp., 2004.

[35] Kouamé-Sina S. M., "Contribution à la gestion des risques de contamination microbienne et diversité génotypiquique des èspèces du genre Bifidobacterium isolées de la chaine de production du lait local à Abidjan". Thèse de doctorat. Université Nangui Abrogoua, 234p, 2013.

[36] Cissé S. A. "Contribution à l'étude de la pasteurisation du lait : faisabilité technique et contrôle de la qualité dans la région de Kolda". Thèse de doctorat. Université Cheikh Anta Diop. 143p, 1997.

[37] FAO, "Les bonnes pratiques d'hygiène dans la préparation et la fabrication des aliments de rue en Afrique". ISBN 92-5-205583-5, 2007.

[38] CODEX STAN 212. *Norme codex pour les sucres*. p5, 1999.

[39] FAO/OMS. Principes généraux d'hygiène alimentaire. p23, 2011.

[40] Ogunshe A. A.O., Adetola A. A., and Adetunji V. O., "Hazard analysis critical control points of farmyard production of wara – a popular nigerian cattle milk food", *Journal of Agricultural and Environnement*. 15 (1): 69-82, 2015.

[41] CXS 243-2003, Rév.2008, 2010, 2018. Norme pour les laits fermentés, 2003.

[42] Schneider M., Kouyaté H., Fokou G., Zinsstag J., Traoré A., Amadou M. et Bonfoh B., "*Dynamiques d'adaptation des femmes aux transformations des systèmes laitiers périurbains en Afrique de l'Ouest*". *Élevage et Médecine vétérinaire des Pays tropicaux*, 60 (1-4) : 121-131, 2007.