International Journal of Social Sciences: Current and Future Research Trends (IJSSCFRT)
ISSN: 2790-4008
https://ijsscfrtjournal.isrra.org/index.php/Social_Science_Journal

Determination of Production Parameters and Socio-demographic Profile of Whey Producers

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Abstract

Despite the multiple nutritional values, mainly linked to lactose, proteins, calcium and phosphorus contained in whey, it is thrown into the immediate environment after the production of Fulani "Wagashi" cheese, thus constituting a source of pollution. This activity was initiated to study the production parameters and socio-demographic profiles of whey producers to promote it in animal feed. Appropriate information was collected by individual interviews with 60 female producers and 30 breeders in cattle farms in the maritime region of Togo to assess various parameters such as general characteristics of the producers, Fresh milk temperature, typology of producers, process and production duration. The snowball method with a participatory approach was used. Multiple correspondence factor analysis (MCFA) and ascending hierarchical classification (AHC) methods were used for analyses of the data obtained. The results showed that all of the producers were women, 100% illiterate and predominantly Fulani (96.7%). Three groups I, II and III of producers were identified. The manufacturing process consisted of seven inherent steps. The temperature (T_0) of fresh milk on the farms just after milking was between 36.62 ± 0.29 to 36.68 ± 0.31°C. The maximum cooking temperature and duration were 69.07 ± 5.19°C and 52.66 ± 13.08 minutes respectively. The price of fresh milk in these farms was 300 FCFA/liter. Depending on the distance, it rose to 429 ± 62.55 FCFA at the places of production. In group II, 80% of the whey was discarded into the environment. A recycling policy is necessary in order to valorize whey.

Keywords: Female producers; fresh milk; immediate Togo environment; whey.

Received: 9/10/2023
Accepted: 10/15/2023
Published: 10/26/2023

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1. Introduction

Cattle milk and meat are essential sources of income and protein for food security. National production of fresh whole cow's milk was estimated at 13,878,644 liters in 2012 in Togo **[1]**. The local marketing channel for milk and dairy products is essentially informal **[1]**. Kulo and Kossivi **[2]** showed that 515 liters of fresh cow's milk are sold daily in Lomé (Togo) of which 28.9% comes from local production and 71.1% is imported from Ghana. Nutritionally, milk is rich in vitamin D with anti-rickety power and therefore its consumption plays an important metabolic role in the absorption of calcium and phosphorus **[3] [4]**. In West African countries, milk is poorly valued because of its high perishability due to the generally high ambient temperature (30 to 45°C) [5]. Under these conditions, the absence of an appropriate cold chain, therefore, imposes the need for actors in the dairy chain to implement conservation or processing techniques more or less adapted to the socio-economic and environmental context **[6].** The fresh milk provided by the milking of dairy cows is mainly processed into artisanal products such as curds, pasteurized milk, fresh cheese “Wagashi” and butter. Instead, local dairies have used imported milk powder, which they process into pasteurized milk, plain or flavored yogurt, “degue” and ice cream. The semi-modern one provides pasteurized milk, and curdled milk in different compositions (sorghum porridge, flavored and others). Imported dairy products cover a wide variety including, among others, pasteurized milk, yogurt, creams and cheeses of different types (“Tchoukoutou” cheese, “Wagashi” cheese). Known under the current name of "Wagashi" in Togo and more specifically of “Gassiré” in the local language “Fulfudé”, Fulani cheese is a soft cheese of high nutritional value, obtained by hot coagulation of fresh whole milk, under the action of calotropaine, a plant enzyme from Calotropis procera **[7]**. It is the most widespread product and therefore, most consumed **[6].** As an important source of cheaper protein, cheese is very popular and highly patronized by the people of Benin, Togo, Nigeria and other countries in the West African sub-region [8] [9]. Its manufacturing technology **[10]**, microbiological quality **[6]** and preservation techniques (by chemical additives, heat treatments and fermentation strains) have been extensively studied [10]. The techniques of conservation of "Wagashi" tested in vitro by the use of strains such as Lactobacillus plantarum **[9]** and chemical preservatives (sorbates, propionic acid and sodium nitrate) are unfortunately not relayed to processors of milk into cheese due to their working conditions (insufficient hygiene in the context of production, very low level of education, etc.). Currently, the world has witnessed a very important development in the industrial sector while there are still risks and adverse consequences on the environment and public health. This is the case with the dairy industry, which unfortunately has not yet found a way to manufacture cheese without co-producing whey. The latter is currently discharged into the wastewater of the factories, but given its high organic matter content (serum proteins, vitamins, lactose, mineral salts) causes a pollution problem for the environment. Representing at least 85% of milk processed into cheese; its recovery is an economic and ecological issue since it has a chemical oxygen demand (COD) of 50 to 70 g/L, which makes it a polluting product that can no longer be released into nature **[11].** Therefore, it can be used in animal feed. The objective of this activity is to study the production parameters and the sociodemographic profiles of whey producers.

2. Materials and methods

2.1. Equipment

The equipment used was composed of a digital thermometer with probe and sensor brand H-9269 which made it possible to take the various temperature measurements in the field (Figure 1), a survey questionnaire and a laptop for taking pictures and the timing of the different stages of production of Fulani cheese or "Wagashi" fresh cheese and whey.

Figure 1: Digital thermometer with probe and sensor brand H-926.

2.2. Sampling device

2.2.1. Study zone

The study was carried out in the Maritime Region of Togo, particularly in the prefectures of LACS and ZIO. According to Kotoe and colleagues **[12]**, the maritime region enjoys a subequatorial climate characterized by a large rainy season that extends from March to July, a short rainy season from September to October, a prolonged dry season from November to February and a short dry season, which covers the month of August. The average temperature varies between 20°C and 35°C. The vegetation consists of wooded savannah crossed by gallery forests in places. In accordance with the biomass of the pasture, three ecological seasons have been determined corresponding to the vegetative stages of the pastures: these are the dry season, the post-drought season and the rainy season **[12]**. All these conditions are favorable to the rearing of cattle and therefore justify the choice of the study environment.

2.2.2. Collection of data

The interview survey method with a participatory approach was used to observe the different manufacturing processes for "Wagashi" fresh cheese and whey. Data were collected at each stage of the manufacturing process with the different equipment that was used. In total, 90 samples were collected from the respondents concerned, namely: 15 herdsmen and 30 producers of "Wagashi" fresh cheese and whey in the LACS and ZIO districts, respectively. Temperatures T_0 were taken in the fields during the milking of the cows followed up at the place of processing where the temperatures T_1, T_2 and T_3 were taken during the production of this fresh cheese and whey. Both qualitative and quantitative data were collected during the study. For questionnaire sampling, the non-probability sampling method through snowball sampling was used **[13]**. Each sample was made from a small number of known individuals who met the desired characteristics. Subsequently, other respondents were added

from recommendations made by the people interviewed. This method was chosen because it is less expensive since it does not require a pre-survey for the preliminary estimate of the sample size before the survey phase. The statistical units of the survey were the herdsmen and producers of fresh cheese "Wagashi" and whey. The survey was conducted based on a questionnaire developed as sheets addressing four points:

- section 0 _ demographic information;
- section 1 _ identification and economic activities;
- section 2 _ raw milk supply and
- Section 3 _ manufacturing process of fresh cheese "Wagashi" and whey.

2.3. Statistical analysis

The survey data were entered into Excel 2016 software before being imported into R-4.2.1 software (R Core Team Development) for statistical analysis. A Multiple Correspondence Analysis (FAMC), followed by an Ascending Hierarchical Classification (AHC) was performed on the data on their socio-demographic characteristics using the R software FactoMiner package **[14]**. The different groups obtained were then compared with one another. A chi-square test ($\chi 2$) followed by a two-tailed Z test was used for qualitative variables (sex, ethnicity, marital status, religion, nationality and level of education). For the quantitative variables (temperature, age, price per liter of milk, work experiment and quantity of milk supply), the non-parametric Kruskal-Wallis test followed by the Mann-Whitney U test was used **[15]**. The significance level retained was 5% ($p < 0.05$).

3. Results

3.1. Variation in temperature of fresh milk and duration of unit operations

Table 1 presents the temperature variation and duration of unit operations during the production of fresh "Wagashi" cheese and whey.

Table 1: Determination of temperature and duration of unit operations during the production of fresh cheese "Wagashi" and whey

Parameters	Indicators	Districts	
		LACS	ZIO
Temperature	T_0	36.68 ± 0.31	36.62 ± 0.29
	FL	34.19 ± 1.82	34.04 ± 1.64
	Pst	61.76 ± 5.32	61.98 ± 6.40
	CF	69.07 ± 5.19	68.89 ± 4.34
Time	DP	32.73 ± 6.59	33.53 ± 4.86
	DC	18.60 ± 8.74	19.13 ± 8.22

T_0: Temperature of fresh milk just after milking, FL: Fresh milk, Pst: Pasteurization, CF: Cooking fresh cheese "Wagashi" and whey, DP: Duration of pasteurization, DF: Duration of cheese Cooking fresh "Wagashi" and whey.

3.2. Whey production process

The dairy industry in Togo is marked by the small-scale processing of fresh milk and the industrial processing of imported milk powder. All ingredients used in the manufacture of cheese "Wagashi" and whey were natural products of animal and plant sources that were accessible in the more or less immediate environment by the producers. These are fresh cow's milk and Calotropis procera. This “Wagashi” fresh cheese and whey were produced on an artisanal scale, following an empirical production protocol described in 7 successive steps, namely (Figure 9):

3.2.1. Step 1: Milking of dairy cows

At this stage, fresh milk is obtained. Its temperature (T_0) in the farms just after milking was between 36.62 ± 0.29 to 36.68 ± 0.31° C respectively in the prefectures of LACS and ZIO (Table 1 and Figure 2).

Figure 2: Milking of a dairy cow on a beef farm.

3.2. 2. Step 2: Filtration of fresh milk

It was an operation during which fresh milk was filtered or cleaned. This cleaning was done using a colander or a filter cloth which retains waste such as midges, animal hair, grains of sand, and others. The product obtained during this step is called purified fresh milk or cleaned fresh milk. The temperature (T_1) of this cleaned fresh milk varied respectively between 34.04 ± 1.64 to 34.19 ± 1.82°C in the LACS and ZIO districts (Table 1 and Figure 3).

Figure 3: Filtration of fresh milk for the production of "Wagashi" cheese and whey.

3.2.3. Step 3: Pasteurization or thermos-controlled debacterization of fresh milk

During this operation (Figure 4a), there was a preparation of the coagulant from an extract of a local plant called Calotropis procera, the common names of which are: the apple tree of Sodom, roustonnier, ball tree, silk tree, tree of Satan, etc. Its vernacular names were: "Boloti" and "Wangash-Gbé" respectively in Ewé and Mina in Togo while in Benin, they were called "Amonman" and "Wagachiman" in Fon and Adja then bamabome in Fulani (Figure 4b). During the preparation of this coagulant, the fruit, stem and rind were the three different parts of Calotropis procera used (Figures 5a and b). They were pounded in a mortar where sodium chloride (NaCl) or cooking salt was added to make the juice (Figures 5c and d). This salt gave a bland taste to the cheeses. The product obtained after pounding is mixed with either fresh milk or water. After mixing, the producers obtained a homogeneous mixture, which was filtered through a colander to obtain the coagulant juice. In this process, the amount of salt was not weighed. This juice was poured over fresh pasteurized milk, the temperature (T_2) of which was raised from 61.76 ± 5.32 to 61.98 ± 6.40°C in the production areas. This pasteurization lasted 32.73 ± 6.59 to 33.53 ± 4.86 minutes (Table 1). This juice could also be obtained from the leaves of Calotropis procera. However, the use of these leaves would have given a greenish color to the cheeses: hence its non-use in the manufacture of the said cheese. The product obtained at this stage is called: fresh pasteurized milk.

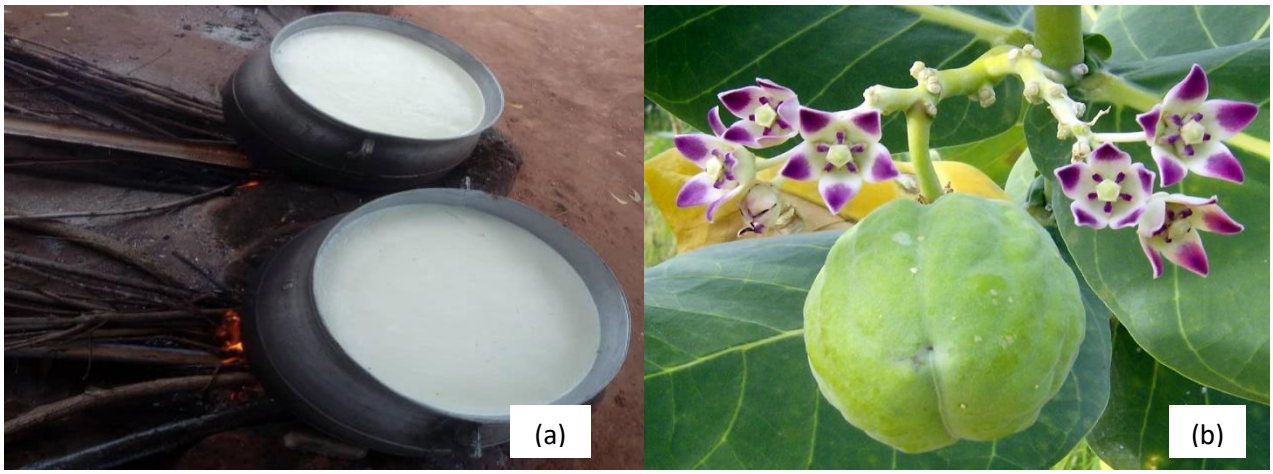

Figure 4: Pasteurization of fresh cow's milk. (a) Heating fresh milk to a temperature varying between 61.76 ± 5.32 to 61.98 ± 6.40°C for pasteurization and (b) Calotropice procera plant.

3.2.4. Step 4: Coagulation of fresh pasteurized milk

During this operation, heating is continued until the complete coagulation of the fresh pasteurized milk. Indeed, the continuation of this heating was essential for the serum or whey to come out of the coagulum. The optimum temperature (T_3) for cooking the coagulum and whey was 69.07 ± 5.19°C during production in the two survey areas (LACS and ZIO). This step marks the end of the cooking of the coagulum and the whey and lasted 18.60 ± 8.74 to 19.13 ± 8.22 minutes (Table 1). Two products were obtained at this stage: the coagulum or the gel which was deposited and the whey or the serum which covered its surface (Figure 5).

Figure 5: Preparation of the coagulant. (a) Fruit of Calotropis procera; (b) Stem and bark of Calotropis procera; (c) Mortar used for looting and (d) Stem + bark of Calotropis procera + salt all pounded.

3.2.5. Step 5: Separation of the coagulum and whey

The coagulum and whey are separated using the van, plastic molds and/or small baskets and a basin. The whey is collected in a basin and served to animals for consumption or discharged into the environment or even donated where it entered human food (used as a solvent to prepare yam) (Figure 6. a, b, c, and d).

3.2.6. Step 6: Molding or draining

Figure 6: Coagulum and whey separation utensils. (a) Basin or plastic containing plastic molds and/or small baskets; (b) Van placed on a basin on which the small baskets are spread out; (c) Separation of the coagulum and the whey and (d) Use of whey in animal production as a drink.

It made it possible to separate the whey from the coagulum. The utensils and procedure used were the same as those used in Step 5 (Figure 7).

Figure 7: Draining or molding of the coagulum.

3.2.7. Step 7: Flipping

It allowed the two sides of the cheese to be more or less homogenized. This step marked the end of the manufacturing process. The cheese obtained is called “Wagashi” (fresh cheese) and can be eaten directly or intended for sale (Figure 8).

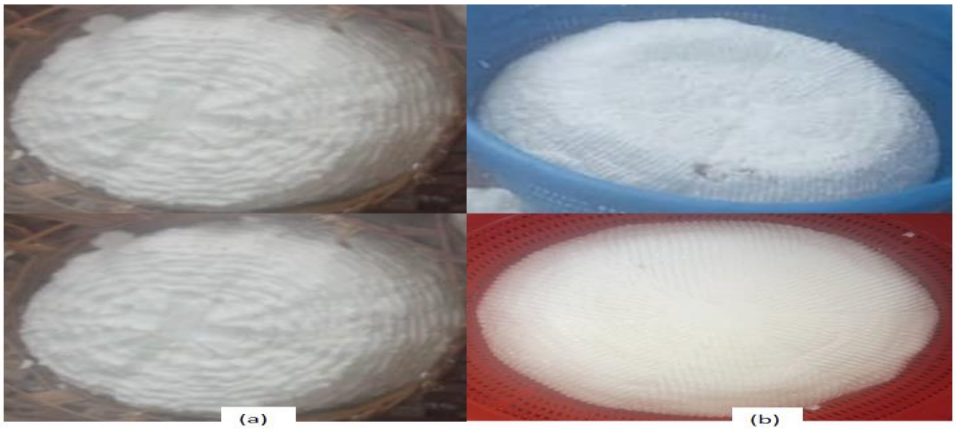

Figure 8: Overturned fresh cheeses.

Table 2 represents the observations made during the investigation and the descriptive summary of the manufacturing protocol of fresh cheese "Wagashi" and whey.

Table 2 : Observations and synthesis of "Wagashi" fresh cheese and whey production techniques

Operations unitary (not modern)	**Raw material**	**Description of unit operations**	**Utensils used (materials)**	**Products obtained**	**Tempe-rature (°C)**	**Duration of the operation in minutes**	**Observations**
Filtration (Figure 3)	Fresh milk	Fresh milk received is filtered or cleaned to remove any waste	Colander or filter cloth	Milk purified or cleaned	34.04 ± 1.64 to 34.19 ± 1.82	Variable depending on the amount of fresh milk	- When the milk is not fresh, no "Wagashi" cheese is made; - No means of preserving fresh milk is available; - The orange color of this cheese is due to the coloring by Sorghum panicum extract but no cheese has been colored; - The quality of the milk used played a key role in the quality of the cheeses since the presence of antibiotics influences the development of bacteria; - Chemyosin can be used for Coagulation but only Calotropice procera juice has been used
Pasteurization or debacterization thermocontrolled (Figure 4)	Fresh milk	The fresh milk has been preheated in order to destroy a large number of microorganisms, particularly pathogenic or damaging under the thermal effect	Embers or bundles	Fresh pasteurized milk	61.76 ± 5.32 to 61.98 ± 6.40	32.73 ± 6.59 to 33.53 ± 4.86	
Coagulation of fresh pasteurized milk (Figure 5)	Fresh milk + vegetable coagulant	Coagulation results in the passage of the milk liquid to make a state of gel or coagulum	Embers or bundles	Coagulum or gel and whey or serum	69.07 ± 5.19 to 68.89 ± 4.34	18.60 ± 8.74 to 19.13 ± 8.22	
Casting or draining (Figures 6 and 7)		The van is placed on a basin and then the small colanders and/or baskets are spread out on the latter. Using a bowl, the coagulum and whey were removed. They are distributed in the colanders and/or baskets taking into account their quantity which is linked to the selling price of "Wagashi" cheese on the market	Van, bowl and strainers and / or small baskets	drained Coagulum		Variable depending on the amount of coagulum obtained after coagulation of fresh pasteurized milk	
Flipping (Figure 8)		After draining, the coagulum contained in each small colander or basket is turned over by hand very quickly because of the hot state of the coagulum		Fulani cheese or "Wagashi" fresh cheese		Variable depending on the number of colanders or baskets to be turned	

3.3. Whey technological diagram

Figure 9 is the technological diagram that describes the whey production protocol.

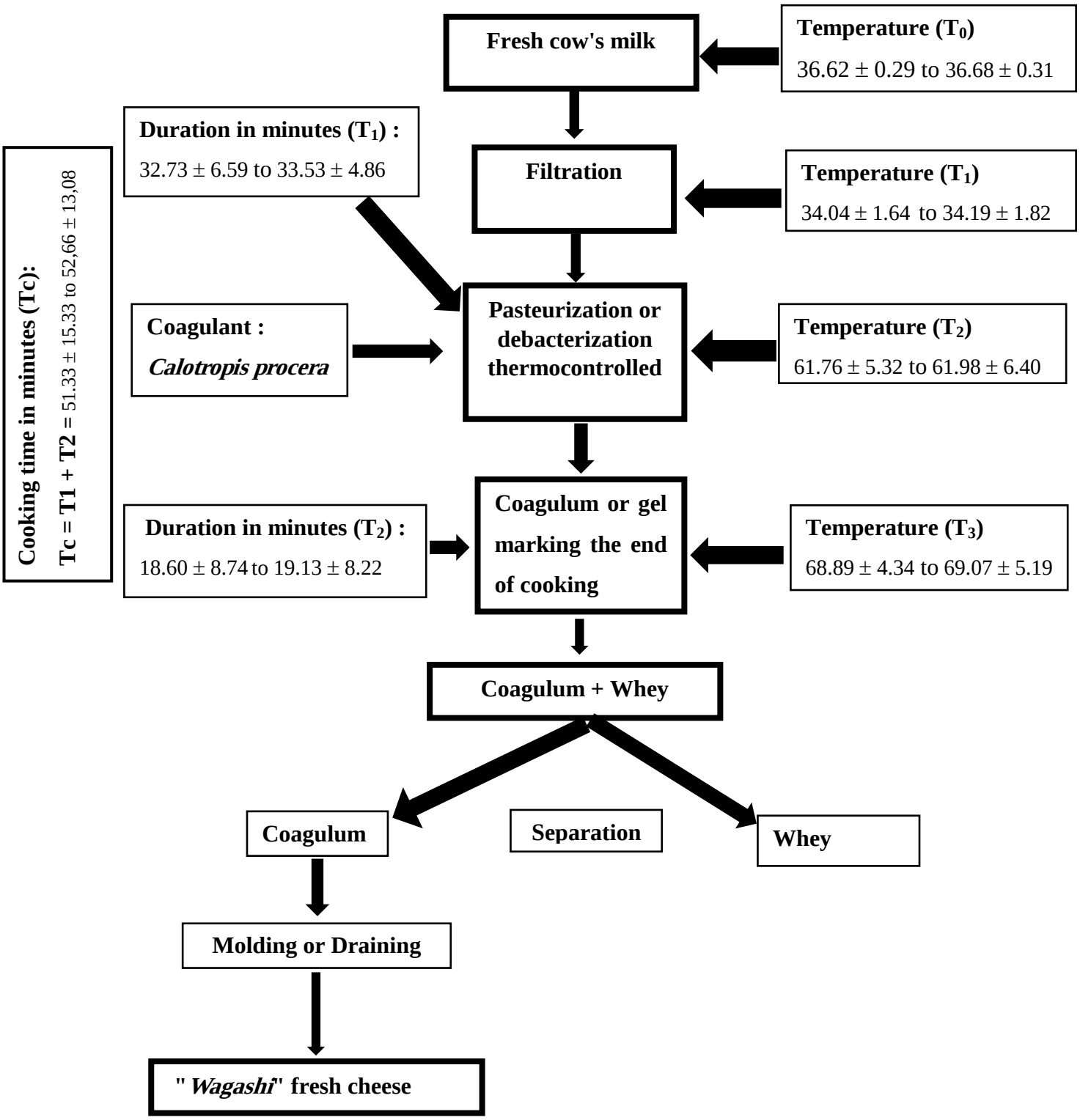

Figure 9: Technological diagram of whey

3.4. General characteristics of producers

Table 3 presents the socio-demographic profiles of women producers of "Wagashi" cheese and whey surveyed in the Maritime Region of Togo: LACS and ZIO prefectures.

Table 3: Socio-demographic profiles of the producers.

Qualitative variables	**Percent (%)**
Sex	
Male	0
Female	100
Ethnic group	
Ewé	3.3
Fulani	96.7
Educational level	
Schooled	0
Unschooled	100
Marital status	
Single	6.7
Married	63.3
Widow	30
Religion	
Islam	96.7
Christianity	3.3
Nationality	
Togolese	3.3
Nigerien	96.7
Quantitative variables	**Mean ± SD**
Age (year)	51 ± 15
Experience (years)	29 ± 16
Price of "Wagashi" (FCFA)	425 ± 69
Price fresh milk (FCFA)	300

The socio-demographic profiles of the producers of fresh cheese "Wagashi" and whey are shown in Table 3 above. The results revealed that all producers of this cheese and whey were women (100%). The average age in years of all these women surveyed was 51 ± 15. The number of years of the experiment was 29 ± 16. The fresh cheese "Wagashi" and whey were made by 96.7% of Nigerien women residing in Togo and 3.3% of Togolese women. The production of the cheese and whey was learned from a parent by Nigeriens and friends by Togolese. These producers belonged mainly to the socio-cultural groups Fulani (96.7%) and Ewé (3.3%). All the producers of the cheese and whey were not educated (100%) with 96.7% Muslim and 3.3% Christian. Regarding their

marital status, 6.7% were single, 63.3% married and 30% widowed. All of the fresh milk (100%) was purchased from the herdsmen whose average cost per liter was generally 425 ± 69 FCFA.

Figure 10 shows three (03) clusters producing fresh cheese "Wagashi" and whey in the districts of LACS and ZIO in Togo. These clusters were characterized by an over-representation of female individuals.

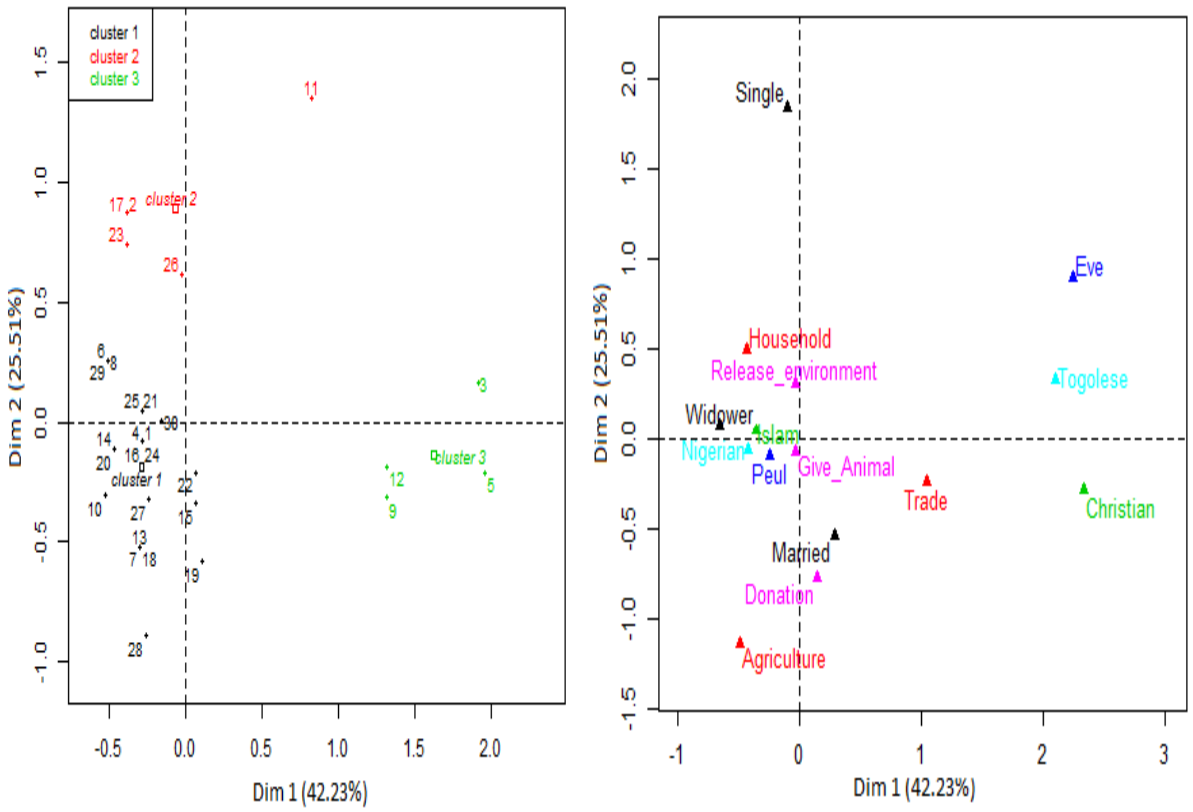

Figure 10: Representation of producers of fresh cheese "Wagashi" and whey according to their membership clusters. The first graph (a) represents the clusters and the second (b) the variables that characterize them. Cluster I: Group I, Cluster II: Group II and Cluster III: Group III.

3.5. Typology of producers

Figure 11 presents the dendrogram producing fresh cheese "Wagashi" and whey in the districts of LACS and ZIO in Togo

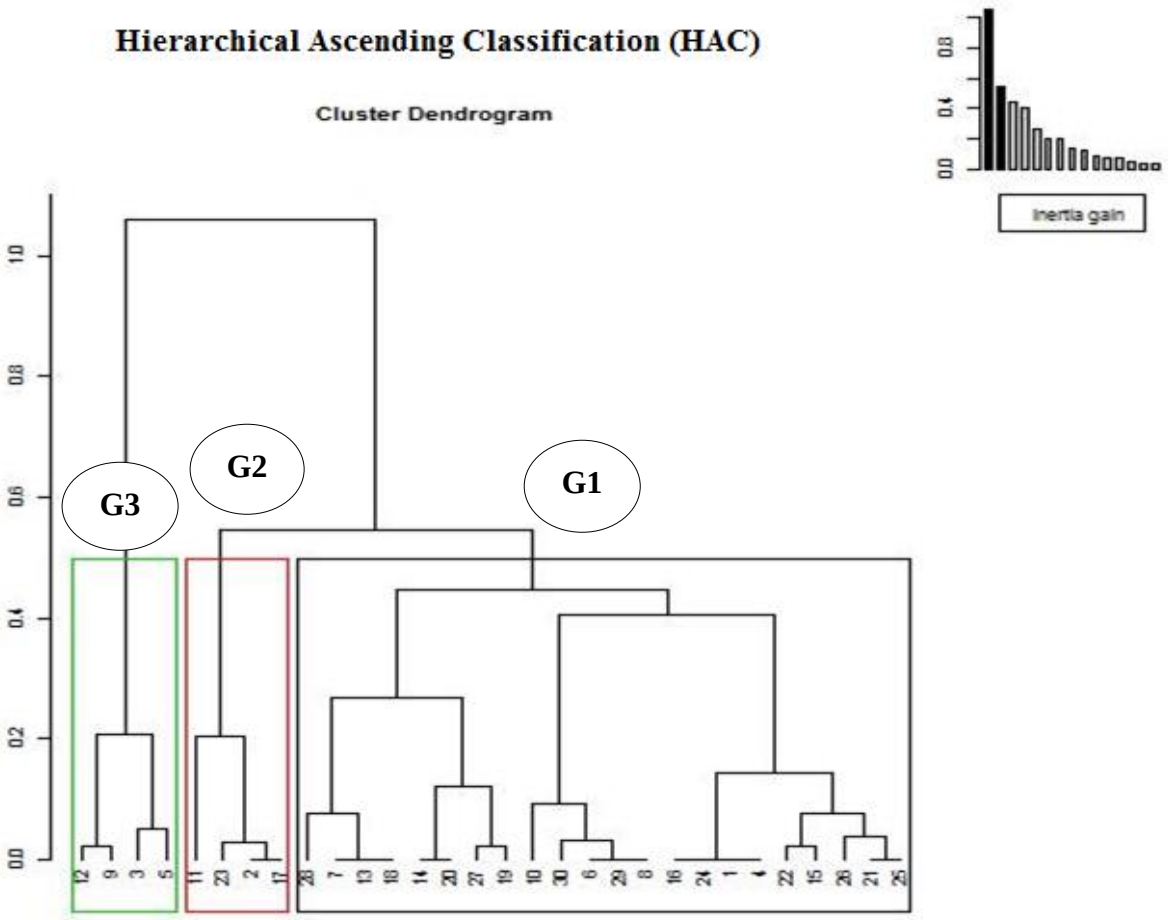

Figure 11 : shows that there were three groups of women producing fresh cheese "Wagashi" and whey in the districts of LACS and ZIO of the Togo Maritime Region. The analysis of the coordinates of the main projection axes of the AFCM was summarized in Table 4 and the cumulative contribution to the total inertia of the first three (03) factorial axes selected was 79.85%.

Table 4: Cumulative contribution to the total inertia of the factor axes.

Factorial axes	% of inertia	Cumulative %
1	42.23	42.23
2	25.51	67.74
3	12.11	79.85

The three factorial axes obtained from Multiple Correspondence Analysis (MCA) made it possible to have a cumulative percentage of variance (79.85) and were therefore taken into account for the interpretation of the results (Table 5). From the first; second and third factorial axes (Figure 11), three types of groups of producers of this fresh cheese "Wagashi" and whey were identified with their characteristics.

Table 5: Comparison of socio-professional characteristics of producers of fresh cheese "Wagashi" and whey.

Parameters	Modalities	Groups		
		Group I	Group II	Group III
Percent (%)				
Ethnic group	Fulani	100^{a}	20^{b}	50^{c}
	Ewé	0^{c}	80^{a}	50^{b}
Marital status	Single	0^{b}	100^{a}	0^{b}
	Married	66.7^{b}	0^{c}	100^{a}
	Widow	33.33^{a}	0^{b}	0^{b}
Secondary activity	Trade	19^{b}	20^{b}	100^{a}
	Agriculture	23.8^{a}	0^{b}	0^{b}
	Household	57.1^{b}	80^{a}	0^{c}
Religion	Islam	100^{a}	100^{a}	0^{b}
	Christianity	0^{b}	0^{b}	100^{a}
Nationality	Nigerien	100^{a}	20^{b}	0^{c}
	Togolese	0^{c}	80^{b}	100^{a}
Use of whey	Donation	23.8^{a}	00^{b}	25^{a}
	Give to animals	23.8^{a}	20^{a}	25^{a}
	Release to the environment	52.4^{b}	80^{a}	50^{b}
Mean ± SD				
Age (years)	-	57 ± 10.40^{a}	16 ± 1^{b}	52 ± 12.90^{a}
Experience	-	31 ± 15.75^{a}	03 ± 02.72^{b}	25 ± 15.81^{a}
Price per liter (FCFA)	-	429 ± 62.55^{a}	415 ± 85.87^{a}	412 ± 103.07^{a}
Supply quantity (L)	-	92.50 ± 34.76^{a}	25.4 ± 34.46^{b}	63 ± 28.86^{c}

The average indexed the same line of the same letter is not significantly different at the 5% level.All the producers of "Wagashi" fresh cheese and group I whey belonged to the Fulani socio-cultural group (100%). Most of them were married (66.7%) and the rest of these producers were widowed (33.33%). Among them, 57.1% do housework, 23.8% agriculture and 19% trade. All (100%) of these producers were Muslim and of Nigerien nationality. After the production of this cheese, whey was released into the environment by 52.4% of them, 23.8% gave it to animals and 23.8% donated it. The average age of these producers was 57 ± 10.40 years and most of the respondents were experienced women with 31 ± 15.75 years of experience. The quantity of fresh milk supplied per day was 92.50 ± 34.76 liters (L) at the unit price of 429 ± 62.55 FCFA. The producers of fresh cheese "Wagashi" and whey from group II belonged mainly to the socio-cultural group Ewé (80%) and the minority Fulani (20%). They were all young (16 ± 1 years old), 100% single and had a professional experience of 03 ± 02.72 years. Most of them were housewives (80%) and the rest were trading (20%). In this group, in 80% of the cases, the whey was released into the environment and 20% gave it to animals. The daily supply of fresh milk was 25.4 ± 34.46 liters (L) at 415 ± 85.87 FCFA per liter. The producers of fresh cheese "Wagashi" and whey group III fairly belonged to the Fulani socio-cultural group (50%) and Ewé (50%). They were all Togolese (100%), Christian (100%), married (100%) and all of them practiced trade as a secondary activity (100%). In this group, 50% rejected the whey into the environment, 25% gave it to animals and 25% gave it out in the form of

donations. They were aged 52 ± 12.90 years and moderately experienced 25 ± 15.81 years. The daily amount of fresh milk received was 63 ± 28.86 liters (L) and the unit price per liter of the milk was 412 ± 103.07 CFA.

4. Discussion

The objective of this activity is to study the production parameters and socio-demographic profiles of whey producers. The results of this study showed that the production of whey, a co-product of "Wagashi" fresh cheese in the prefectures of LACS and ZIO is practiced by women. This observation is explained by the fact that the production of cheese and whey is a culinary activity and until then remains artisanal. This result is consistent with those obtained by Fournier and colleagues **[16]** and Gaspar and Vertheine, **[17]** who underlined that the issues of food have a differentiated impact on women and that culinary activity remains more dependent on them. Actors in this sector of activity were dominated by the Fulani socio-cultural group of Nigerien nationality with a percentage of 96.7% against 3.3% Ewé who were of Togolese origin. They were all out of school (100%), predominantly Muslim, married, elderly (51 ± 15 years) and had a professional experience of 29 ± 16 years. These very important characteristics of socio-anthropological data would be explained by the fact that most of the farms visited during this survey were mainly the private property of the Fulanis. Also, it could be linked to the promotion of women in the dairy sector in order to respect the gender approach in this sector of activity to grow the household economy and therefore the national economy. These results were consistent with those found by Kulo and Kossivi, **[2]** for having carried out research on the dairy sector, in particular fresh cow's milk in the city of Lomé. According to these authors, the production and marketing chains of fresh cow's milk were mainly owned by Nigeriens (87.5%) and Burkinabè (12.5%) who were 85.7% illiterate. In addition, research carried out by Issa and colleagues [**18**] on the dairy chain showed that when the herds were owned by men in the herding communities of sub-Saharan Africa, the management of the fresh milk resource fell under women. They participated in the collection of this milk, but above all in the processing and marketing of the derived products, as well as in the management of the income generated by the activity.

Thus, in the cheese business, fresh cheese "Wagashi" and whey were produced at a small scale following an empirical manufacturing protocol described in the seven (7) successive steps: milking fresh milk to obtain the raw material, filtration of fresh milk, thermo-controlled pasteurization or debacterization of fresh milk, coagulation of fresh pasteurized milk, separation of coagulum and whey, molding or draining and turning.

Across the entire production chain, the results relating to the different temperatures of fresh milk up to the point of cooking the fresh cheese "Wagashi" and whey were all similar ($P > 0.05$) irrespective of the district considered. They are the same for the duration in minutes of the unit operations. The temperature of fresh milk during milking on the cattle farms varied from 36.62 ± 0.29 to 36.68 ± 0.31° C. The noted rise in the temperature of fresh milk immediately after milking could be because cows are homeotherms (warm-blooded) while the free fall in this temperature can be related to the change in ambient temperature. After pasteurization, heating of the pasteurized fresh milk continued and the cooking temperature of this cheese and the recorded whey ranged from 68.89 ± 4.34 to 69.07 ± 5.19°C. These results are similar to those obtained by Dubey and Jagannadham, **[19]**, Singh and colleagues **[20]** and Aworh and colleagues **[21]**. According to these authors, several enzymes have been isolated from Calotropis procera and have proteolytic activity leading to the coagulation of fresh milk in

dairy cheese. Their activation is linked to an optimum temperature which varies from one enzyme to another. These are: proceraine A (55-60°C) **[19]**, proceraine B (40-60°C) [**20**], calotropaine **[7]** and proteinase I and II (50°C) **[21]**. Among these enzymes, the action of procerain A and B would be highlighted in this coagulation since the coagulant was added to fresh pasteurized milk at 61.98 ± 6.40°C. Similarly, other research carried out by Cavot & Lorient, **[22]** and Jovanovic and colleagues **[23]** showed that a high temperature of 75°C resulted in the inactivation of chymosin during the production of the curd. Wolf, **[3]** and Janz & Pearson, **[4]** have shown that milk is the main dietary source of vitamin D and research by Damicz and colleagues **[24]** has shown that in fluid milk, pasteurization at 75°C for 15 minutes decreased the protein content. Pierre and colleagues [**25**] have also shown that soluble proteins were more sensitive to thermal denaturation after heating for 30 minutes at 95°C. Thus, during the manufacture of "Wagashi" cheese and whey, pasteurization lasted 32.73 ± 6.59 to 33.53 ± 4.86 minutes while the coagulation of fresh milk lasted 18.60 ± 8.74 to 19.13 ± 8.22 minutes, making a total of 51.33 ± 15.33 to 52.66 ± 13.08 minutes for cooking. It, therefore, follows that heating fresh milk above 75°C makes the proteins sensitive and consequently reduces the nutritional quality of “Wagashi” cheese and whey. These results are contrary to those obtained by Dossou and colleagues **[8]** who showed that the cooking temperature of “Wagashi” cheese and whey was around 100°C. In the chosen survey area (Maritime region, LACS prefecture and ZIO), three groups (I, II, and III) of women producers were identified with quite different characteristics. In the farms where this milk was produced, a liter cost 300 FCFA. Depending on the distance between these farms and the places of production of these cheese and whey, this price varied to an optimum of 429 ± 62.55 FCFA. This variation is linked to the cost implication of transport. Among the three groups of producers (I, II and III) identified, the results showed that there was a significant difference between the values relating to the daily supply quantities of fresh milk with a trend expressing a positive impact where the amount of liters of fresh milk processed per day was higher in group I). This observation can be explained by the fact that the producers of this group had a high production capacity unlike those of groups II and III. This can also be due to the advanced age of these producers or to the high professional experience in this group. Among these women, the production of this cheese was learned from a relative of the Nigerians and a Fulani friend of the Togolese. This represents a legacy resulting from accumulated empirical knowledge and is transmitted from generation to generation. It was the main activity for these women along with other secondary activities such as agriculture, trade and housework. Among the observations made in the field, these producers were confronted with the problems of the curdling of fresh milk since they had no means of conservation. Fresh cheese "Wagashi" and whey were finished products of the cheese industry. Unfortunately, whey management poses real problems. Between these three groups identified, the statistical analysis revealed that there was a significant difference between the values of the modalities relating to whey management. In group II, 80% of whey was released into the immediate environment. This trend was perceived as a negative impact since it constitutes a source of environmental pollution. In groups I and III, respectively, 23.8% and 25% of the whey was used for donation. In this case, it goes into animal feed (used as drinking water) or human feed (used as a solvent to prepare yam). These results are in line with those obtained by Kim and colleagues. [**27**] and Bouassi and colleagues [**26**]. According to these authors, diluting this whey in drinking water improved production performance in pigs and laying hens.

5. Conclusion

Whey, a co-product of "Wagashi" fresh cheese, was produced on an artisanal scale, following an empirical manufacturing protocol described in 07 successive stages, namely: milking of dairy cows, filtration of fresh milk, pasteurization of fresh milk, coagulation of fresh pasteurized milk, separation of coagulum and whey, molding or draining and turning. The optimum cooking temperature recorded was 69.07 ± 5.19°C or 70°C. All unit operations in this protocol have a total duration of 52.66 ± 13.08 minutes. These producers mainly belonged to the Fulani socio-cultural group and all of them were illiterate. Three groups of producers of fresh cheese "Wagashi" and whey were identified. After production, 23.8% of this whey in Group I served as a donation and 25% in Group III was given to animals. However, 80% of this whey was thrown into the immediate environment.

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