Global Scientific JOURNALS

GSJ: Volume 6, Issue 9, September 2018, Online: ISSN 2320-9186
www.globalscientificjournal.com

TRADITIONAL DAIRY PRODUCTS IN THE REPUBLIC OF BENIN: WAGASHI AND DÈGUÈ

Oscar ZANNOU[1]*, Dehouegnon Jerry AGOSSOU[2], Ilkay KOCA[1]

[1]*Department of Food Engineering, Ondokuz Mayis University, 55139, Samsun, Turkey*

[2]*Department of Animal Science, Çukurova University, 01130, Adana, Turkey*

Corresponding author: zannouoscar@gmail.com

Abstract

Production of cereals and milk is particularly important in West Africa. These two commodities occupy an important place in the staple diet of the populations of West African countries. This study underlined the state of the technological process of the main traditional milk-based foods produced in the Republic of Benin, the identification of their hygienic and safety levels, and the preservation methods. The results indicated that wagashi cheese and dèguè are the main traditional milk-based foods widely produced and consumed. Wagashi is a traditional cheese produced with local fresh milk and a plant coagulum extracted from *Calotropis procera*. Dèguè is a traditional beverage obtained by mixing steamed dumplings cereals, mainly millet and fermented milk. These feed are characterized by an interesting nutritional quality and an acceptable hygienic quality. However, organoleptic aspects and preservation techniques remain to be improved, hence the need for their promotion by standardized technologies.

Keywords: *Wagashi*, *Dèguè*, *Calotropis procera*, Republic of Benin.

1. Introduction

The economy of the most of West African countries is fundamentally based on agriculture and breeding. In the Republic of Benin, agriculture and breeding play a preponderant role in the economy and lives of the population, occupying the biggest part of the active population. Among livestock drifted products, cow's milk plays a major role in these communities [1]. The promotion of milk production and its transformation are clearly notified in the economic strategies of the Republic of Benin as a massive production of milk will generate great income and employment. High consumption of the milk and milk products will likewise permit to fight against hunger and malnutrition. Milk is generally processed in hand for seeking of gains, diversification of dairy products, improving of organoleptic qualities, perishability, improving hygienic quality, valorization of the components, and facilitation of the transportation. In other hand for an increase of the shelf life, availability, formulation of new products and insufficiency of the cold line. Milk is an important food for the populations in developing countries regarding its high nutritional value as it contains proteins, carbohydrates, lipids, vitamins and minerals contents. In Africa, the milk is often consumed raw, processed in yogurt, curdled milk, milk powder, non-sweetened condensed milk and sweetened condensed milk and traditional dairy products. Nowadays, the production and consumption of traditional dairy products in the Republic of Benin are wildely spred in both rural regions and big cities.

The present work capitalizes and makes more available endogenous knowledge and research assets that educate communities about the technology of production, hygiene and safety, and conservation of traditional dairy products of the Republic of Benin.

2. Socioethnical and religious aspects of milk processing in the Republic of Benin

The farming is the main activity of the Republic of Benin people where crops are consumed alone or in mixture. Traditionally, cattle breed is the main activity of *Peulh* or *fulani* ethnical group. *Peulhs* are mainly located in the North and Central part of the Republic of Benin, however, they permanently move with their livestock according to the season. With objective to feed and give water to their animals, they follow raining season. This tradject can bring them to the South part of the country. In spite of their permanent moving life style, they ethnical group is legislated with traditional rules and forbiden. One these rules stipulated that milk cannot be brought back to farm. Since then, after family or self-consumption of the fresh milk, it is processed in traditional dairy products such as *wagashi* and *dèguè*. In the ancient time, *wagashi* was eaten raw and could replaced meat or fish in sauce, whereas, *dèguè* was mainly drunk by muslum during last broking time. *Wagashi* was considered as a protein source, while, *dèguè* was known a an energitical beverage. To date, *wagashi* is one the most widespread dairy product and the most used in the Republic of Benin. It is also produced and consumed in some West African countries like Nigeria, Burkina Faso, Ghana, and Togo. Likewise, *dèguè* became popular and widely produced and consumed in Republic of Benin, Ivory Coast, Senegal, Burkina Faso and Mali; particularly as weaning foods and dietary staples [2,3,4,5].

3. Preservation and hygienic aspects of preparation and consumption of traditional dairy products in the Republic of Benin

From ancient time to now, a food product takes considerable time to reach the table of the consumer. During time-consuming steps involved in handling, storage, and transportation, products start to dehydrate, deteriorate, and lose appearance, flavor and nutritional value. If no

special protection is provided, damage can occur within hours or days, even if this damage is not immediately visible.

3.1. Preservation of wagashi and dèguè

3.1.1. *Preservation of wagashi*

The rapid perishability is the most important problem faced by producers and consumers of *wagashi* in the Republic of Benin. Since then, several techniques have been traditionally practiced to preserve as longer as possible this dairy product. Endogenous conservation techniques consisting in one hand of dipping the product in whey, proper water and plant extracts (*Sorghum vulgaris*, *Sorghum caudatum*, *Vitellaria paradoxa*, *Pennisetum polystachion* and *Piliostigma thonningii*), and in other hands of sun-drying, daily heating (65-70 °C/20minutes), frying, and traditional smoking. Most of these techniques can extend the shelf life of *wagashi* to 12 days, whereas, the smoked product is the most preserved and can last thirty days [6].

Recently, laboratory researches have been done to verify endogenous conservation techniques, figure out new techniques and harmonize parameters. So, it was discovered that *wagashi* dipped in the whey keeps intact the nutritive value during three days of storage with a decrease of coliform bacterial count [7]. Electronic oven drying performed at 45°c for 48 hours revealed to preserve physicochemical characteristics of *wagashi* and microbial loads are effectively reduced at the same optimum condition [8]. Aworh and Egounlety [9] with the goal to extend the shelf life of *wagashi* stored at 7-9°C, suggested chemical treatment using 1% sorbic acid and 10% propionoic acid. It resulted that the treated products can be conserved up to 20 days while non-treated products have deteriorated after 9 days. However, the organoleptic quality of chemical treated *wagashi* was affected. Keke et al [10] advocated the injection of *Lactobacillus plantarum* in drained *wagashi* and the results were satisfactory in terms of decrease of microbial loads and physicochemical properties but the treatment

generated an acidified taste in the product. Furthermore, salting and frozen techniques provided long storage time as they can preserve *wagashi* until one month, even though frozen altered the texture [11]. These treatments showed an improvement in the shelf life of *wagashi* but the organoleptic qualities are wrecked and it is well-known that sensory qualities are important for the acceptability of a foodstuff. Some plants with antimicrobial characteristics have been investigated for *wagashi* cheese preservation. Essential oils or extracts from various parts of *Cinnamomum zeylanicum*, *Syzygium aromaticum*, *Ocimum gratissimum*, *Cymbopogon citratus* L., *Sorghum vulgaris* (L), *Mentha spicata* L. and *Moringa oleifera* showed antimicrobial activities in *wagashi* cheese [12,13,14,15,16,17,18]. These plants may not only preserve *wagashi* cheese but can also increase medicinal properties of the final product. According to Dossou et al [19], thermic dehydration coupled with vacuum packing showed the best results as *wagashi* cheese can be preserved for two months; even though, the cost of the product makes the application of the developed process difficult in an economical point of view. The Vacuum packaging revealed to be the most effective to prevent microbial alteration of *wagashi* [20].

3.1.1. Preservation of dèguè

Initially, *dèguè* was produced in small scale, the necessary quantity to cover household needs. Even during muslum events *dèguè* was served completely. Nowadays, in the rural communities, people are still producing *dèguè* in small quantity. This fact is due to rapid perishabilty of this berevage, as it contains an important water rate. The only one technique to conserve *dèguè* was the drying of the dumplings cereals, locally known as *fura*. When the dumplings cereals are well-dried can be conserved months, up to *dèguè* production.

To date, d*èguè* is spred in urban streets where cold line can be found. Once produced d*èguè* is either preserved in the fridge at < 5°C where it can last at least 2 days, or served

directly. It worth mentioning that the fermentation step is effective for preservation of foodstuffs [21]. Indeed, during fermentation, the growth of lactic acid bacteria followed by a decrease of pH, leads to the acidification of dèguè [2]. This acidification inhibits the increase of pathogens microorganisms [22] allowing the product to stand longer. On other hands, the shelf life of cereals pellets can increase up to 3 months when it sun-dried for forty-eight hours [23].

3.2. Hygiene and safety of wagashi and dèguè

Hygiene and safety represent two important components of quality that producers have to assure during food processing. Even in the traditional societies, people was conscients about food hygiene and safty. For instance, before to eat a food people are used to heat it.

3.2.1. Hygienic aspects of wagashi

Wagashi is a traditional cheese carries out at the household level and this may compromise the quality of the final product. However, fresh *wagashi* is a safe food with great nutritional value. Indeed, the fresh *wagashi* is consumed raw, especially by children as protein based-food. It can also be incorporated in sauces, particularly in vegetable sauces. Moreover, during *wagashi* making, the decrease of pH and associated with processing conditions of temperature and time, induced a considerable reduction of microbial loads as well as aflatoxin levels [24,25,26]. Likewise, no enterobacteriaceae was found in *wagashi* stored at 25-28°C for 5 days [20]. Nevertheless, the product can be contaminated or microbial loads can increase over the limits if the appropriate conditions are not respected during the distribution, commercializationi and storage. Hygienic and microbiological studies performed on *wagashi* sold in some markets revealed that this cheese is contaminated with microorganisms and sellers do not respect properly hygienic conditions [6,10,27,28,29,30]. Therefore, it is firmly recommended to heat, smoke or fry the *wagashi* cheese before any usage.

3.2.2. Hygiene aspects of dèguè

Dèguè is generally produced at the small or household scales. Therefore, non-sterile equipment, random or natural inoculums, unregulated conditions, sensory variations, earlier perishability, non-suitable packaging [31] as well as bad handling, characterized the conditions of production of this processed product. These conditions may not be guaranteed an absolute hygiene and safety of the obtained product. In addition, most of the producers are housewives of which 45.13% and 50.74% are illiterate and have a primary or secondary level, respectively [32].

Microbiological investigation revealed that the experimented *dèguè* contains no total coliforms or thermotolerant coliforms [2]. According to the same authors, no pathogenic agents have found in studied dèguès, however, lactic acid bacteria, yeasts and molds were found as dominant microflora. Lactic acid bacteria, yeasts and molds count augmented after fermentation with a decrease of pH in *dèguè* [5]. The development of lactic acid bacteria can promote the disappearance of enterobactericeae by the production of bacteriocin [33]. Furthermore, the growth of pathogen microorganisims are inhibited with lowering of pH [5,22]. Moreover, *dèguè* is nowadays considered as a probiotic food as it contains lactic acid bacteria having beneficial effects on human health. Probiotics are microorganisms, particularly lactic acid bacteria, safe for human consumption with great beneficial effects on health [34].

In spite of the production conditions, *dèguè* is revealed to be proper of consumption and good for health when is inserted in children and elders people's diets. In addition, the recent installation of some small and middle scales industries for the production of *dèguè* products makes production and packaging conditions more and more adequate.

4. Popular dairy products of the Republic of Benin

This overview was done in steps. The first step has concerned a survey carried out in the Republic of Benin. The questions were addressed to the aged household members, both men and women. The collected informations concerned knowledge on preparation of ethnic dairy products, consumption style, milk source and ethnic importance. The second step was focused on scientific and literature extant data. All published researches on traditional dairy products of either Republic of Benin or West Africa were included. Then, two common ethnic dairy product including *wagashi* and *dèguè* were figured out. Despite great similarity of preparation techniques, some dissemblances were register depending on region.

4.1. Wagashi cheese

4.1.1. Evolution of preparation technique of wagashi cheese

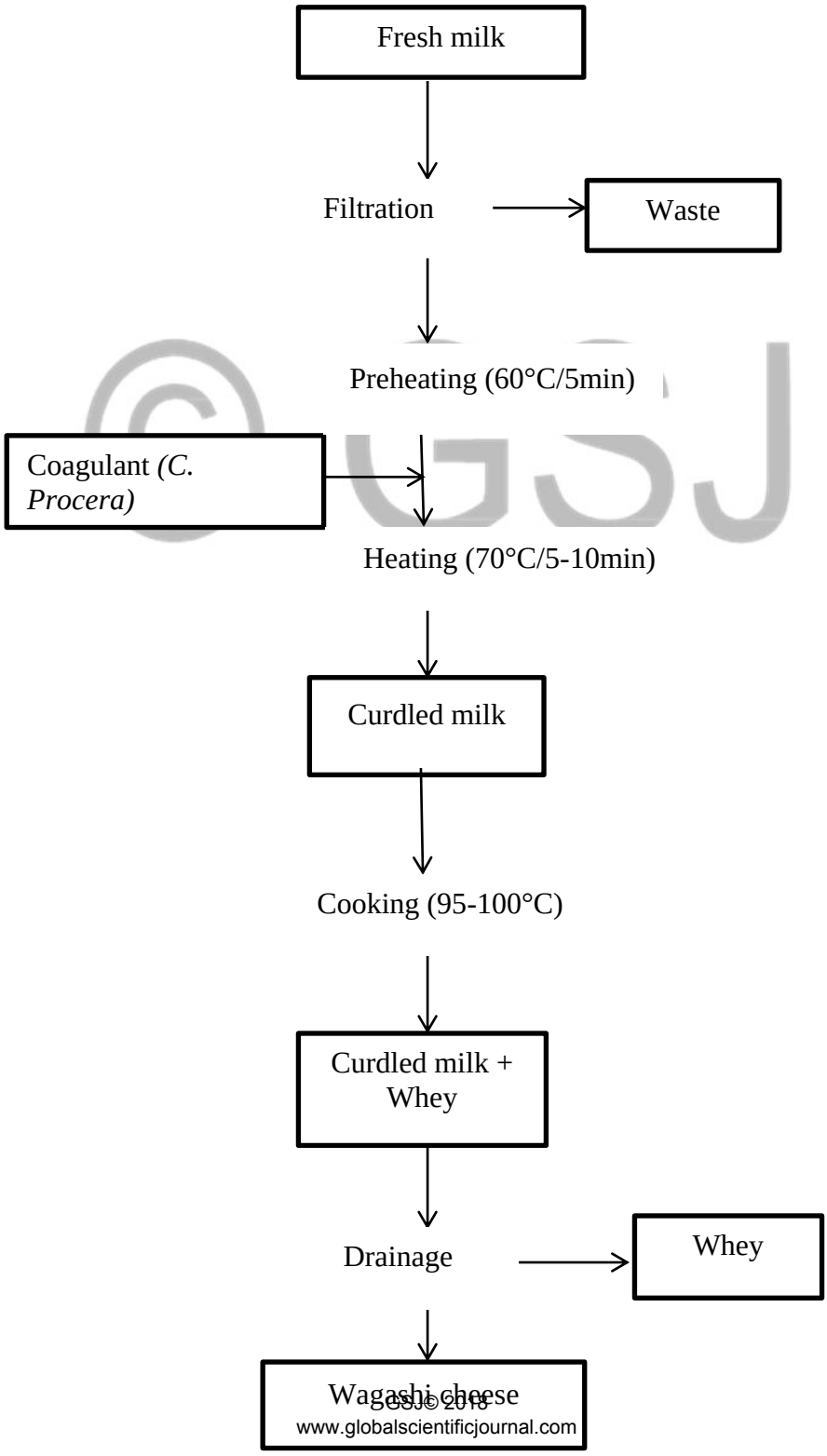
Wagashi is a traditional cheese prepared from cattle milk. This cheese is produced by filtering fresh milk and preheating it at 50-60°C for 5 minutes. Then, the coagulant is added and the mixture is heated up to 95 -100°C until the curdled milk appears on the top of the whey. The curd is separated and cooked again with potash and a coloring agent for a few minute. This operation is facultative. Afterwards, the mixture is dripped as described in Fig. 1. Years ago, various quality of *wagashi* was found in the market depending on production zones and this may due to the lack of standard processing methods. A tend to harmonize wagashi making technology by surveying, revealed that processing methods are mastered, however, microbiological quality of *wagashi* can be affected. Adegoke et al [25] described the procedure used in Oye and Ede, two regions in Nigeria. Later, Dossou et al [35] documented *wagashi* cheese production by gathering extant data and endogenous knowledge. Indeed, to produce 1 Kg of *wagashi* cheese 5 L of cow's milk [36] or 5.3 L of alpine goat's milk [37] are

used and the time varies between 1 to 3 hours depending on the quantity of the fresh milk. More recently, coconut milk has been successfully incorporated into cow's milk at 1:9 rate during *wagashi* manufacturing [38]. The production of *wagashi* cheese is untill now an important economical activity of the ethnic group *Peulh*, however, the commercization and consumption are spred in both rural and urban communities.

4.1.2. Coagulant: Calotropis procera

Calotropis procera (Aiton) T.W. Aiton also named Sodom apple is one of the species of genus *Calotropis* from family Asclepiadaceae [39]. *Calotropis procera* is originated from Africa, India, and Middle East; and can thrive in an arid climate. This plant is used as a vegetable coagulant during *wagashi* cheese making. Its main active ingredient involving in cheese's coagulation is calotropin enzym. The extraction of the coagulum consist of washing the leaves and stem of *C. procera*. The washed leaves and stem are ground or crushed, mixed with water and then filtered (**Fig. 2**). The filtrate is added to the milk with brief stirring while the heating continues. The factors which affect the processing of *wagashi* are mainly the milk origin and composition, *C. procera* extract rate and temperature of stimulation of the enzyms as well as milk composition. Elolo et al. [40] compared the reactivity of certain plant coagulants including bromelin, calotropin, and papain, and observed that the activity of these enzymes starts slowly at low temperatures to reach an optimum between 60-70 °C; but among these three enzymes, calotropin provided not only the best organoleptic quality but also the highest cheese yield. The adequate amount of *C. procera* for milk to be clotted is questionable in the extant literature. For producers of the Reublic of Benin, a quantity of 5-12g of *C. procera* is necessary for an efficient clotting of 1 kg of milk [35]. Similarly, Kees [36] suggested 20g of *C. procera* to clot 1kg of milk. Coagulant extracted form fresh leaves of this vegetable was experimented and it was resulted a cheese

with great nutritional and sensory properties [41]. Other studies focused on the optimization and rationalization of *C. procera* during the production of *wagashi*, revealed that 13 minutes is enough to coagulate one liter of cow's milk with 30.08% of production yield, using an optimum amount of 35g/L of an extract containing 90% of fresh stems and 10% of fresh leaves [42]. Coagulant properties of different parts including leaves, stems, fruits and latex of



C. procera has been investigated and it resulted that latex showed the highest activity at optimum conditions of temperature (65-70°C) and pH (7-8) [43]. In addition, the coagulant properties of *C. procera* may be affected by the season and geographical situation.

Besides its use as plant coagulum during traditional *wagashi* cheese production, *C. procera* is also well-known for its various medicinal usages as it is used to cure malaria and infections deseases. Different parts of *C. procera* including leaf, root, flower, juice, latex, bark and fruit in multiple preparations are used in traditional medicine to relieve or treat several ailments including intestinal worms, skin illnesses, coughing, ascites, digestive

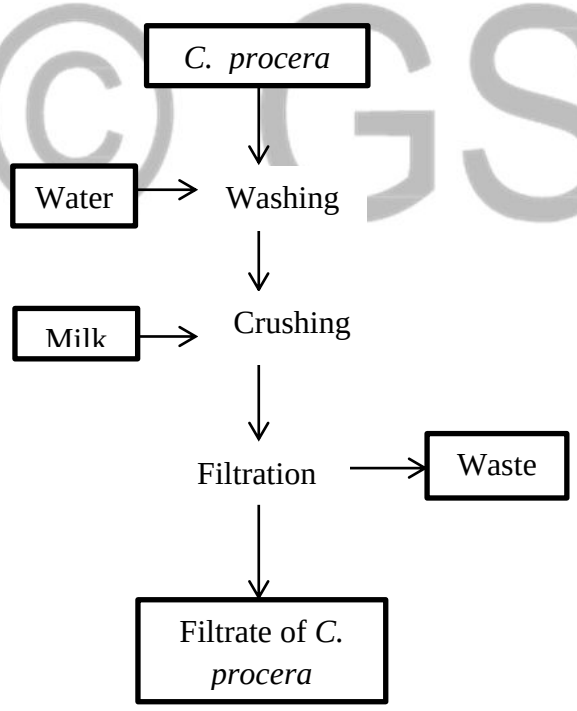


Fig. 2. Flow diagram of extraction of the coagulant

troubles, elephantiasis, toothache, leprosy, asthma, hepatic, parlysis, wound healing, cholera, improvement of bile secretion and migraine [44]. Extant studies reported analgesic, antioxidant, anticancer, antidiabetic, anti-inflammatory, cytotoxic, antinociceptives and anti-isoproterenol properties in *C. procera* latex of [45,46,47,48]. Moreover, extracts of *C. procera* root and bark displayed anticonvulsant and immunomodulation effects, respectively [47,49]. These health beneficiaries may be linked to the fact that different parts of *C. procera* contain useful phytochemical compounds such as cardenolides, coumarins, flavonoids, triterpenes, sterols, alkaloids, tannins, saponins, proteases, hydrocarbons, fatty acids, resins, amino-acids, and so [39,44,50,51,52,53]. Likewise, biomass of *C. procera* is also used to feed animals.

4.1.3. Coloration

The coloration is one of the particularity and authenticity of *wagashi* cheese (**Fig. 3**). The cheese is colored into the red or light red, using panicles of *Sorghum vulgaris*, young leaves of *Tectona grandis* and/or bark of *Vitellaria paradoxa*. The goal of this operation consists of making the cheese more pleasant or attractive. The use of these plants may enhance medicinal properties of the cheese, as they are used in traditional pharmacopeia to prevent or treat several deseases. The coloration has a preservative effect on *wagashi* cheese.

Fig.3. Photographs of white *wagashi* and red *wagashi*.

4.2. Production of dèguè

4.2.1. Evolution of preparation technique of dèguè

Dèguè is a fermented beverage made gathering steamed dumpling cereals and fermented milk (**Fig. 4**). Initially, *dèguè* was made with millet (*Pennisetum glaucum*) and the fermentation concerns only the milk which is added to the precooked millet flour dumplings. The producers use almost the same technology which is empirically transfererd. Few years in the past, the level of production has been growing rapidly due to the increase in street and urban consumption. *Dèguè* is manufactured by women and sold in public places, along lanes, local markets, schools, universities wedding and festival places, as well as supermarkets. Today, *dèguè* is made from three major cereals such as millet (*Pennisetum glaucum*), maize (*Zea mays*) and sorghum (*Sorghum bicolor*). Hama et al [5] reported that *dèguè* is produced in Burkina Faso with a fermented millet flour lumps of which the fermentation step can last 2, 3 or 7 days with respect to consumers acidic desire. Tchekessi et al [2] with the objective to improve nutritional qualities and safety of this fermented drink, finalized the production process by assembling endogenous knowledge and scientific experiments. *Dèguè* is made with three major stages comprising pellets production, fermented milk production and assembly of both pellets and fermented milk.

Fig. 4. Photograph of *dèguè*

4.2.2. Production of pellets

The pellets (**Fig. 5**) are steam cooked dumpling cereals. Initially, they were made from millet. However, maize and sorghum pellets were introduced since the consumption of *dèguè* overpassed rural areas. Before pellets' manufacturing, grains of cereals are sorted, sieved, washed (three times) and drained. The cleaned up cereals are then sun-dried for 48 hours and ground [2,23]. The cleaning is an important operation which consists of removing the most spoiled or rotten grains, debris, undesirable particles or any kind of impurity. During the process, the dough is made by mixing about two thirds (2/3) of the flour with of pure water and then stirred until a homogeneous paste is obtained. Afterward, the dough is hand rolled with progressive addition of the remaining one third (1/3). Finally, the obtained pellets are steam cooked for 20 minutes (**Fig. 6**). The rolling is tiresome, hard and tedious as they are done manually [2,32]. Nowadays, the manufactured wheat couscous and fonio couscous are available in the market and are successfully used by some producers.

Fig. 5. Photograph of cereal pellets

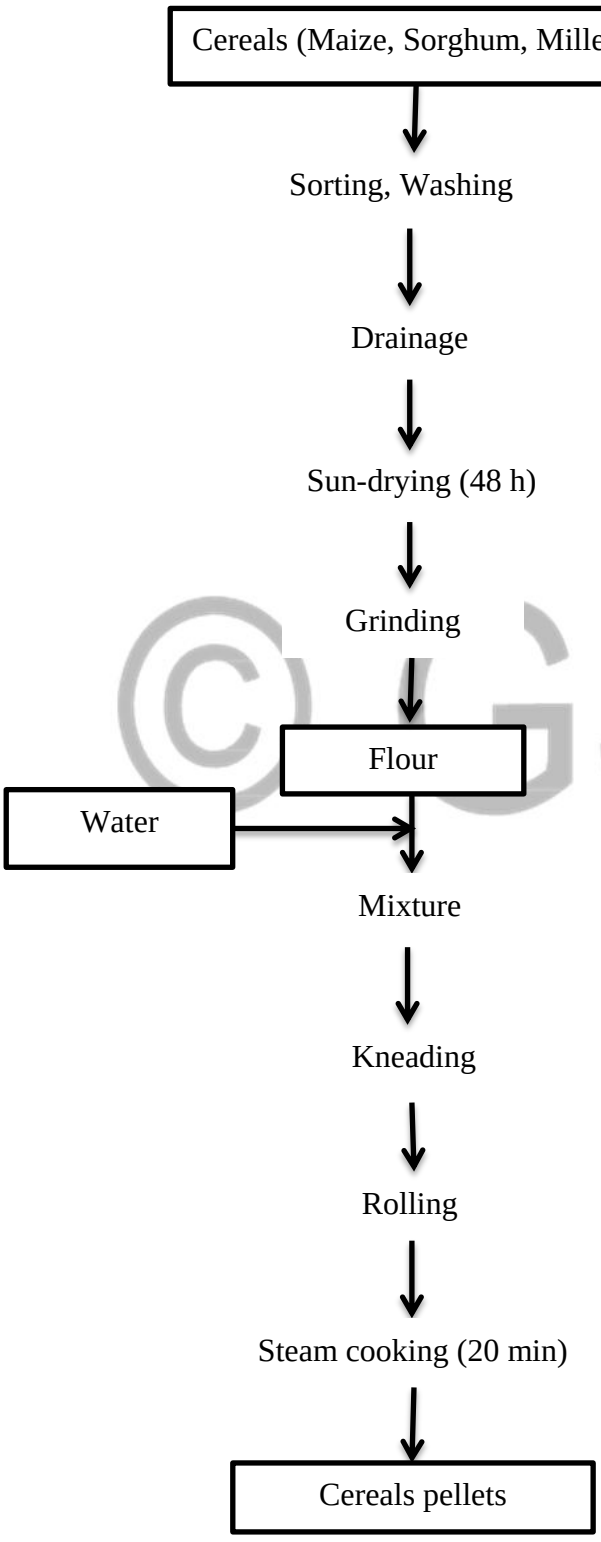


Fig. 6. Diagram of production of cereal pellets

4.2.3. Production of the fermented milk

The second most important stage involved in the processing of *dèguè* is the production of the fermented milk or yogurt. Only cow's milk was used to produce the fermented milk as it was the most important local source of fresh milk. However, since the introduction of milk powder in the local markets, the producers adopted the reconstituted milk powder [32] because milk powder is ful-time available in an affordable cost. The production of the fermented milk using reconstituted milk powder was improved by Tchekessi et al [2] in laboratory scale and described as follows: 1Kg of milk powder is mixed with 7 L of warmed water (35 °C). The mixture is pasteurized at 80 °C for 5 minutes and then cooled to 45 °C. At this temperature, the pasteurized was inoculated with nature yogurt which is commercial yogurt produced in the Republic of Benin, and then left for 8 hours.

4.2.4. Mixture of pellets and fermented milk

The last step consists of mixing the cereals pellets and the fermented milk followed by a second short time fermentation which lasts two hours as described in **Fig. 6**. Millet pellets were originally used, but recently, maize pellets, sorghum pellets, fonio couscous and wheat couscous are successfully introduced. Furthermore, it resulted from the sensory analysis that sorghum-based *dèguè* is more appreciated [55].

5. Usage and nutritional aspects of traditional dairy products in the Republic of Benin

Milk is also traditionally processed (sometime combined with cereals) in various drifted products including *wagashi* (Peulh cheese produced in Benin, Ghana, Togo and Nigeria), *dèguè* (Milk

and cereals-based food produced in Benin and Burkina Faso), *mabisi* (a fermented milk-based beverage produced in Zambia), *kule naoto* produced in Kenya and Tanzania, *gappal* (milk and cereals based food found in Burkina Faso), *fura* (milk and cereals-based food found in Burkina Faso, Nigeria, and Ghana), *ikivuguto* (produced in Rwanda) and Mahgreb regions' traditional dairy products such as *rayeb* (curdled milk), *leben*, raw butter (*zebda beldi*) and *smen* (clarified butter). The ethnic milk processing and the commercialization of the traditional dairy products are often ensured by women allowing them to be empowered and to contribute to the livelihoods of the family and the schooling of children. In the Republic of Benin, the milk production increased from 62425950 L in 1997 to 104130000 L en 2013 [56]. In spite of this augmentation in production, national demand is far away from being covered.

5.1. Ethnical usage and nutritional aspects of *wagashi*

Wagashi also named *waragashi*, is an appreciated local cheese originally produced by the ethnical group *Peulh* also named *Fulani*. It is generally produced using cow's milk, however, alpine goat's milk was experimented recently with success in the Republic of Benin [37]. This cheese has great nutritional value [57] and it often replaces animal proteins such as eggs, meats, and fish in the local dishes. Indeed, waragashi is cut, fried or smoked and then incorporated to local dishes such as cooking rice and sauces, especially vegetable-based sauces. The nutritional composition of fresh *wagashi* varies slightly between studies, probably due to animal breeding conditions [58] and preparation parameters. Studies reported that wagashi contains moisture (49.7-70.75%), fat (26.15-39.00%), protein (18.32-37.08%), ash (2.53), total solids (29.25-30.3) [4,11,59,60], as well as vitamins and minerals. *Wagashi* cheese is popular and widely consumed in rural zones as well as big cities.

5.2. Ethnical usage and nutritional aspects of *dèguè*

Most of the fermented foods produced in West Africa involves milk, cereals and/or tubers. *Dèguè* is a traditional beverage obtained by mixing steamed cereals pellets and

fermented milk. Cereals involved in the production of this fermented drink are maize (*Zea mays*), sorghum (*Sorghum bicolor*) and mainly millet (*Pennisetum glaucum*) as they are highly cultivated in the Republic of Benin. *Dèguè* was traditioanally used as an energetical and children growth stimulative beverage. Then, it was mostly drunk during lasting and weaning periods. It revealed that *dèguè* contains good nutritional value as milk and cereals have high nutritive properties. Tchekessi et al. [2] investigated the physicochemical characteristics of maize, sorghum and millet-based dèguè with the objective to determine nutrients present in this beverage. As results, pH, protein (%), dry matter (%), ash (%) and total sugar (%) for maize-based *dèguè* are 4.21, 13.95, 20.1, 0.72 and 6.47, respectively; those for sorghum-based *dèguè* are 4.22, 13.64, 21.2, 0.75 and 5.29, respectively and those for millet-based *dèguè* are 4.27, 13.93, 22.2, 0.74 and 9.5, respectively. In addition, iron and vitamins (A, B1, B2, C essentially) have been found in the valuable quantity into the studied samples. These findings confirmed the importance of this traditional drink regarding the nutrients it contains.

4. Conclusion

This word permit to figure out that wagashi cheese and dèguè are the most important traditional dairy products in the Republic of Benin. The production and commercialization are mainly practiced by women allowing them to be economically empowered. Wagashi cheese remains the main product obtained from the processing of fresh milk. Perspectively, improvement actions regarding the hygiene conditions, the appropriate methods of preservation, presentation or packaging, and distribution of these products should be carried out.

Conflicts of interest

All authors declare no conflicts of interest.

References

[1] Katinan CR., Aw S, Chatigre KO, Bohoussou KM, Assidjo, NE. Assessment of chemical and microbiological quality of home-made fermented milk produced and consumed in Yamoussoukro town, Côte d'Ivoire. J Appl Biosci 2012; 55: 4020-27.

[2] Tchekessi CKC, Bokossa A, Adigun N, Bleoussi R, Sachi P, Banon J, Agbangla C, Azokpota P, Bokossa IY. Physico-chemical and sensory characterizations of three types of "*dèguè*", a local fermented drink made from milk in Benin. Int J Biosci 2014; 5: 36-43.

[3] Soro-Yao AA, Brou K, Koffi-Nevry R, Djè K. Microbiology of Ivorian fermented products: A review. Asi J Agric Food Sci 2013; 1: 37-47.

[4] Soro-Yao, AA, Brou, K, Koussémon, M, Djè, KM. Proximate composition and microbiological quality of millet gruels sold in Abidjan (Côte d'Ivoire). Int J Agri Innov Res 2014; 2: 472-79.

[5] Hama F, Savadogo A, Ouattara CAT, Traore AS. Microbiochemical, microbial and processing study of *dèguè* a fermented food (from pearl millet dough) from Burkina Faso. Parkistan J Nutr 2009; 8: 759-64.

[6] Sessou P, Farougou S, Azokpota P, Youssao I, Yèhouénou B, Ahounou S, Sohounhloue, CKD. Inventaire et analyse des pratiques endogènes de conservation du wagashi, un fromage traditionnel produit au Bénin. Int J Biol Chem Sci 2013;7:938-52.

[7] Alalade OA, Adeneye JA. The effect of storage period on the chemical and coliform microflora of *wara* cheese. Int J Dairy Sci 2006;1:126-30.

[8] Tchobo F, Ahouannou C, Amegnoin AN, Mazou M, Alitonou GA, Sohounhloue CKD, Soumanou MM. Physico-chemical and microbiological characteristics of dried *waragashi*. Afr J Food Sci 2014;8:447-55.

[9] Aworh OC, Egounlety M. Preservation of West African soft cheese by chemical treatment. J Dairy Res 1985;52:189-95.

[10] Keke M, Yèhouénou B, Dahouénon E, Ossou J, Sohounhloué DCK. Contribution à l'amélioration de la technologie de fabrication et de conservation du fromage peulh waragashi par injection de *Lactobacillus plantarum*. Ann Sci Agron Bénin 2008;10:73-86.

[11] Mazou M, Tchobo FP, Degnon RG, Mensah GA, Soumanou MM. Effect of temperature and salt on the quality of waragashi cheese during storage in Benin Republic. Afr J Food Sci 2012; 6: 494-99.

[12] Sessou P, Farougou S, Azokpota P, Youssao I, Sohounhloué D. *In vitro* antifungal activities of essential oils extracted from fresh leaves of *Cinnamomum zeylanicum* and *Ocimum gratissimum* against foodborne pathogens for their use as traditional cheese wagashi conservatives. Res Rec Sci 2012;1:67-73.

[13] Keke M, Yehouenou B, de Souza C, Sohounhloue D. Evaluation of hygienic and nutritional quality of peulh cheese treated by *Sorghum vulgarıs* (L) and *Pimenta racemosa* (MILLER) extracts. Scientific Study Res 2009; X:29-46.

[14] Sessou P, Farougou S, Alitonou G, Djenontin TS, Yèhouénou B, Azokpota P, Youssao I, Sohounhloué D. Chemical composition and antifungal activity of essential oil of fresh

leaves of *Ocimum gratissimum* from Benin against six mycotoxigenic fungi isolated from traditional cheese *wagashi*. Int Res J Biological Sci 2012;1:22-7.

[15] Badmos AHA, El-Imam AMA, Ajiboye DJ. The effect of crude leaf extracts of *Moringa oleifera* on the bacterial, nutritional and sensory properties of West African soft cheese. Wayamba J Animal Sci 2014;1:939-46.

[16] Sessou P, Farougou S, Kaneho S, Djenontin S, Alitonou GA, Azokpota P, Youssao I, Sohounhloué D. Bioefficacy of *Cymbopogon citratus* essential oil against foodborne pathogens in culture medium and in traditional cheese wagashi produced in Benin. Int Res J Microbiol 2012;3:406-15.

[17] Zannou A, Konfo CTR, Gbaguidi MAN, Ahoussi-Dahouenon E. Antimicrobial activity of extracts from *Cymbopogon citratus* L. and of *Mentha spicata* L. against fungal and bacterial strains isolated from peuhl's cheese (*Waragashi*) produced in Benin. Int J Adv Res 2015;3:1684-95.

[18] Sessou P, Farougou S, Yèhouénou B, Agniwo B, Alitonou G, Azokpota P, Youssao I,Sohounhloue D. Biological control of spoilage and pathogens moulds in culture medium and Beninese traditonal cheese *wagashi* by *Syzygium aromaticum* essential oil. Afr J Microbiol Res 2013;7:2454-63.

[19] Dossou J, Montcho JK, Londji S, Atchouké GDL, Odjo S. Procédé amélioré de conservation et de stabilisation du fromage peuhl par l'effet combiné du traitement thermique et du conditionnement sous vide. Eur Sci J 2016;12:189-209.

[20] Adetunji VO, Chen J. Effect of temperature and modified vacuum packaging on microbial quality of *wara*, a West African soft cheese. Res J microbiol 2011;6:402-09.

[21] Chavan J, Kadam S, Beuchat LR. Nutritional improvement of cereals by fermentation. Cri Rev Food Sci Nutr 1989;28:349-400.

[22] Tchekessi CKC, Bokossa YI, Banon J, Agbangla C, Adeoti K, Dossou-Yovo P, Assogba E. Caractérisations physico-chimiques et microbiologiques d'une pâte traditionnelle "*gowé*" fabriquée à base de maïs au Bénin. J de la Recherche Scientifique de l'Université de Lomé (Togo) 2013; 15:377-87.

[23] Tchekessi CKC, Bokossa IY, Hounkpatin GJF, Banon J, Adigun N, Sachi P, Agbangla C. Etude socio-économique et technologique de fabrication des boulettes de céréales pour la production d'une boisson fermentée de type probiotique consommée au Bénin. Int J Innov Appl Stu 2014;9:1323-35.

[24] Aïssi MV, Soumanou MM, Bankolè H, Toukourou F, de Souza CA. Evaluation of hygienic and mycological quality of local cheese marketed in Benin. Australia Basic Appl Sci 2009;3:2397-404.

[25] Adegoke GO, Nse EN, Akanni AO. Effects of heat, processing time and pH on the microflora, aflatoxin content and storability of "wara", a soft, white cheese. Die Nahrung 1992;36: 259-64.

[26] Sessou P, Farougou S, Yèhouenou, B, Agbangnan P. Azokpota P, Youssao I, Sohounhloue D. Investigation on aflatoxin M1 content of traditional cheese wagashi produced in Benin. Afr J Food Sci Technol 2013;4:44-7.

[27] Sessou P, Farougou S, Yèhouenou, B, Agbangnan P. Azokpota P, Youssao I, Sohounhloue D. Investigation on aflatoxin M1 content of traditional cheese wagashi produced in Benin. Afr J Food Sci Technol 2013;4:44-7.

[28] Massa-Calpe G. Microbiological quality of cheeses: Importance of good handling practices. Alimentaria 1996;270:69-72.

[29] Sessou P, Farougou S, Azokpota P, Youssao I, Yèhouénou B, Ahounou S, Sohounhloue, CKD. Inventaire et analyse des pratiques endogènes de conservation du wagashi, un fromage traditionnel produit au Bénin. Int J Biol Chem Sci 2013;7:938-52.

[30] Gouissi FM, Assongba H, Assogba GM. Evaluation of the microbiological quality of the cheese-based of cow's milk sold in the markets of Porto-novo (Benin). The Int J Sci Technol 2017;5:67-70.

[31] Olanrewaju OO, Victor OO, Titilayo TA. Safety of small-scale food fermentations in developing countries. Internet J Food Safety 2009;11:29-34.

[32] Tchekessi CKC., Banon J, Seni I, Gandeho J, Agbangla C, Azokpota P, Angelov A, Bokossa YI. Socio-economic study of a fermented drink "*dèguè*" made with milk and cereals in Benin. Int J Multidiscipl Cur Res 2014;2:626-32.

[33] Mensah P, Tomkins AM, Drasa BS, Harrison TJ. Antimicrobial effect of fermented Ghanaian maize dough. J Appl Bacteriol 1991;70:203-10.

[34] Bonifait L, Chandad F, Grenier D. Les probiotiques en santé buccale: mythe ou réalité? J Can Dental Ass 2009;75:585-90.

[35] Dossou J, Hounzangbé-Adoté S, Soulé A. Production et transformation du lait frais en fromage Peulh au Bénin: Guide de bonnes pratiques, avec l'appui financier de la coopération française et du GRET. Université d'Abomey-Calavi/FSA;2006. 23-33 p.

[36] Kees M. Le fromage peuhl : Facile à produire et bienapprécié. Une technologie à vulgariser. GTZ-Bénin; 1996. 12-17 p.

[37] Vissoh D, Gbangboche AB, Kpadonou E. The alpine goat's milk production and cheese yield in Benin. Int J Cur Res 2015; 7: 22108-112.

[38] Okon EG, Ojimelukwe PC. Potentials of coconut milk as a substitute for cow milk in cheese making. J Adv Microbiol 2017;4:1-9.

[39] Sharma AK, Kharb R, Kaur R. Pharmacognostical aspects of *calotropis procera* (Ait.) R. Br. Int Pharm Bio Sci 2011;2:B-480-88.

[40] Elolo GO, Courdjo RL. Propriétés physico-chimiques et réactivité comparées des agents coagulants végétaux dans la fabrication du fromage frais wagasi. J. Rec. Sci.Univ. Lomé (Togo) Série A 2005;7:159-64.

[41] Benyahia-Krid FA, Aissaoui-Zitoun O, Boughellout H, Adoui F, Harkati A, Bakou CR, Wodo D, Zidoune MN. Fresh cheese "peulh type": Characterization and sensory aspects. J Adv Dairy Res 2016;4:.

[42] Aïsso RCB, Aïssi MV, Youssao AKI, Soumanou MM. Caractéristiques physico-chimiques du fromage Peulh produit dans les conditions optimales de coagulation à partir du lait de deux races de vaches du Bénin. Nature & Technolo 2016;14:37- 43.

[43] Baba-Moussa F, Baba-Moussa L, Ahissou H, Bokossa I, Capo-chichi B, Toukourou F, Sanni A. Propriétés coagulantes de *Calotropis procera* et ses possibilités d'utilisation en industrie agro-alimentaire. Rev CAMES-Serie A 2007;5:7-12.

[44] Parihar G, Balekar N. *Calotropis procera*: A phytochemical and pharmacological review. Turkish J Pharm Sci 2016; 40:115-31.

[45] Gupta S, Gupta B, Kapoor K, Sharma P. Ethnopharmocological potential of *Calotropis procera*: An overview. Int Res J Pharm 2012;3:19-22.

[46] Meena AK, Yadav AK, Niranjan US, Singh B, Nagariya AK, Sharma K, *et al*. A review on *Calotropis procera* Linn and its ethnobotany, phytochemical, pharmacological profile. Drug Invent Today 2010;2:185-90.

[47] Quazi S, Mathur K, Arora S. *Calotropis procera*: An overview of its phytochemistry and pharmacology. Indian J Drugs 2013;1:63-9.

[48] Vaiyapuri PS, Ali AA, Mohammad AA, Kandhavelu J, Kandhavelu M. Time lapse microscopy observation of cellular structural changes and image analysis of drug treated cancer cells to characterize the cellular heterogeneity. Environ Toxicol 2015;30:724-34.

[49] Ramos V, Aguiar VC, Melo VM, Mesquita RO, Silvestre PP, Oliveira JS, *et al.* Immunological and allergenic responses induced by latex fractions of *Calotropis procera* (Ait.) R.Br. J Ethnopharmacol 2007;111:115-22.

[50] Saber H, Maharan GH, Rizkallah MM. Sterols and pentacyclic triterpenes of *Calotropis procera*. Bull Fac Pharm 1969;7:91-104.

[52] Tiwari KP, Masood M, Rathore S, Minocha PK. Study of anthocyanins from the flowers of some medicinal plants. Vijnana Parishad Anusandhan Patrika 1978;21:177-8.

[53] Carruthers B, Griffiths DJ, Home V, Williams LR. Hydrocarbons from *Calotropis procera* in Northern Australia Biomass 1984;4:275-82.

[54] Morsy N, Al Sherif EA, Abdel-rassol TMA. Phytochemical analysis of *Calotropis procera* with antimicrobial activity investigation. Main Group Chem 2016;15:267-73.

,[55] Tchekessi CKC, Bokossa A, Agbangla C, Azokpota P, Daube G, Scippo M.L, Korsak N, Angelov A, Bokossa YI. Production and microbiological evaluation of three types of

"Dèguè", a local fermented drink made from milk in Benin. Int J of Multidiscipl Cur Res 2014;2:714-20.

[56] Ministère de l'Agriculture de l'Elevage et de la Pêche de la République du Bénin. Annuaire statistique 2013. MAEP; 2014. 71 p.

[57] Appiah F, Ellis WO, Oduro I. Studies on traditional cheese (Woagashie) production in the Ashanti Region. J Ghana Sci Ass 1998; 1: 96-104.

[58] Tzanetakis N, Litopoulou-Tzanetaki E, Manolkidis K. Microbiology of Kopanisti, a traditional Greek cheese. Food Microbiol 1987; 4: 251-56.

[59] Aworh OC, Muller GH. Cheese-making properties of vegetable rennet from sodom apple (*Calotropis procera*). Food Chem 1987; 26: 71-79.

[60] Olalade OA, Adeneye JA. Effet of storage period on the chemical composition and coliform microflora of wara cheese. Int J Dairy Sci 2006; 1: 126-30.