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Production and microbiological evaluation of three types of "Dèguè", a local fermented drink made from milk in Benin

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Abstract

This study consists to finalize some technologies for the production of a fermented drink called dèguè. This drink is widely consumed in Benin and other countries in sub-Saharan Africa. Following three different technologies, we had produced three (03) types of dèguè respectively with maize flour, sorghum and millet. These types have been analyzed and their microbiological characteristics were evaluated. The microbiological analysis results obtained from the experiments have shown that lactic acid bacteria, yeasts and molds were the dominant microflora of dèguè and varied respectively 7.22log10CFU/g to 7.55log10CFU/g for lactic acid bacteria and 7.78log10CFU/g to 8.44log10CFU/g for yeasts and molds. Moreover, the statistical analysis of these results showed that there was no significant difference at 5% ($p < 0.05$) between the three types of dèguè. The values of lactic acid bacteria obtained were consistent with the standard ($\geq 10^7$/g) attached to the yoghurt. No type contained neither total coliforms nor thermotolerant coliforms. The products (dèguès) were also free of pathogenic microorganisms such as Escherichia coli, Staphylococcus aureus and Salmonella.

Keywords: *cereals, milk, dèguè, fermented drink, production.*

1. Introduction

Raw milk is a highly nutritious product. It is a suspension (micellar casein in equilibrium, somatic and microbial cells), an emulsion of fat globules and lactose with a solution of hundreds of other soluble molecules of which serum proteins high nutritional value, minerals, growth factors, vitamins, hormones [1]. However, the wealth of nutriments and water made him a highly perishable product.

To keep the milk, man constantly sought to preserve it by transforming it. Among the transformation process available, we notice fermentation.

Fermentation is one of the oldest technologies used for food preservation [2]. It is a technology upon which millions of people in the Third-World for the preservation of their food to make them available to the average consumer. For several decades, fermented foods are very important in the human diet; they are mostly made based cereals, tubers and/or milk [3], [4], [5].

In Benin, most fermented products are prepared with cereals. These cereals are available throughout the country. They are primarily used in the food and consist mostly of maize, millet and sorghum.

Moreover, the fermented products of these cereals often serve refreshing beverages commonly consumed in Benin in particular in urban areas where they appreciated especially during periods of extreme heat. Production plays an important role in the Beninese domestic economy [4]. Among these fermented cereal foods placed "dèguè".

As for the fermentation of milk, it consists in the degradation of lactose into lactic acid and lactic acid bacteria multiplication. As products of this fermentation we have the fermented milks.

According to French law, fermented milk is a dairy produce made exclusively from raw materials of dairy origin (milk and milk components), having undergone pasteurization and fermentation by specific

microorganisms and characterized by a lactic acid content minimal (0.6%) [6]. Thus, the yogurt is fermented milk obtained by the development of specific thermophilic lactic acid bacteria *Streptococcus thermophilus* and *Lactobacillus bulgaricus* to be planted simultaneously and be alive in the product in an amount of at least ten (10) millions bacteria per gram of product [7]. In Senegal, the fermented milk is very popular due to its acid but pleasant taste, but also through the expansion of supply by the addition of other foods, such as cereals [8]. This milk added to dumplings of cereals flour is called in Benin "dèguè".

In origin, dèguè is a product made from milk and millet flour. It is a food widely consumed in Benin and beyond to West Africa.

This alimentary product is sold in local markets in Benin, along the lanes, public places, but also in schools and university campuses [9]. Production of dèguè generates jobs of thousands of people especially women, whose education and skills in food processing are often limited. These kinds of foods (aliments) are defined by the FAO (2007) [10] as food and beverages ready for consumption prepared and/or sold by street vendors or fixed, especially in streets and other similar public places. They are produced without any rules of good practices of hygiene of production and marketing. Thus, production environments are not safe, low adequate infrastructure and low grade. Other problems also exist in producing, for example, the non-control manufacturing parameters such as temperature, fermentation processes, etc. This lack of control parameters can cause food-borne infections.

Faced with all these problems related to the consumption of food streets and given the socio-economic importance of dèguè, it is timely important to finalize technologies for the production of different type of dèguè of good health and nutritional qualities.

Material

Maize (*Zea mays L.*), millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) are the three cereals used; they are bought at the local market of the town of Abomey-Calavi.

The yogurt "nature" composed of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* has been bought at the Togoudo pharmacy in the city of Abomey-Calavi. Milk powder of brand LACSTAR of Irish origin bought at the market in Dantokpa at Cotonou served animal material. The water from the National Water Company of Benin (SONEB) was used in the production of dèguè.

Methods

Production of dèguè

Three types of dèguè were manufactured respectively based flours of maize, sorghum and millet, but before this it is necessary to get the pellets of these cereals and fermented milk.

Manufacture of the pellets

The cereal grains weighed, cleaned (sorted out, sieved) and washed three times with tap water were drained and then dried for forty-eight (48) hours under sunlight. Afterwards, the dried clean grains were weighed again and ground in a mill drives brand N°A PREMIER GRINPING with a frequency of 1760tours/min, its power is 25.50kwa to obtain the different flours. 1kg of flour was divided into three equal parts. We took two thirds (2/3) of the aforesaid flour that are mixed with 700mL of water; then stir well and a paste is obtained. The pellets have been made by hand rolling by mixing gradually the third (1/3) of the flour with dough and turning regularly for 5 to 10 minutes. The pellets formed are finally steamed for 15 to 20 minutes. After cooling, they are ready for use.

Production of fermented milk

The fermented milk was obtained from the reconstituted milk powder. Thus, we took 1kg of milk powder that we mix with seven (07) liters of warm water at 35°C; the mixture is then pasteurized at 80°C for 05 minutes then cooled to 45°C. The reconstituted milk was inoculated with nature yoghurt. Finally, the fermented mixture is left at 45°C for 8 hours. For 1kg of milk are added two pots of yoghurt 125g each.

Assessment of microbiological quality

Microbiological analysis consisted in counting the total mesophilic flora [11] on PCA (Oxoid CM 0325), yeasts and molds [12] on Sabouraud Dextrose Agar (Oxoid CM 0041) at chorampphénicol (0.05g/l), lactic acid bacteria [13] on MRS-Agar (Oxoid CM 0361), total coliforms [14] and thermotolerant coliforms [15] on VRBA-Oxoid CM 0107 (Violet Red Bile Agar), *Staphylococcus aureus* [16] on Baird Parker Agar (Oxoid CM 0275 BP) egg yolk and potassium tellurite and *Salmonella* [17] on SS Agar. The counting was done by counting the colonies [18]. Microbiological analyzes were performed in triplicate on each sample dèguè.

Statistical analyzes of data

The Excel software was used to perform the calculations. Analysis results were processed using SPSS 16.0 software that permitted to make analysis of variance (ANOVA) and Tukey's test for comparison of means. The significance level of 5% is selected ($p < 0.05$).

Results and discussion

Manufacture of the pellets

The results of the production technology of different types of pellets are shown in Figure 1.

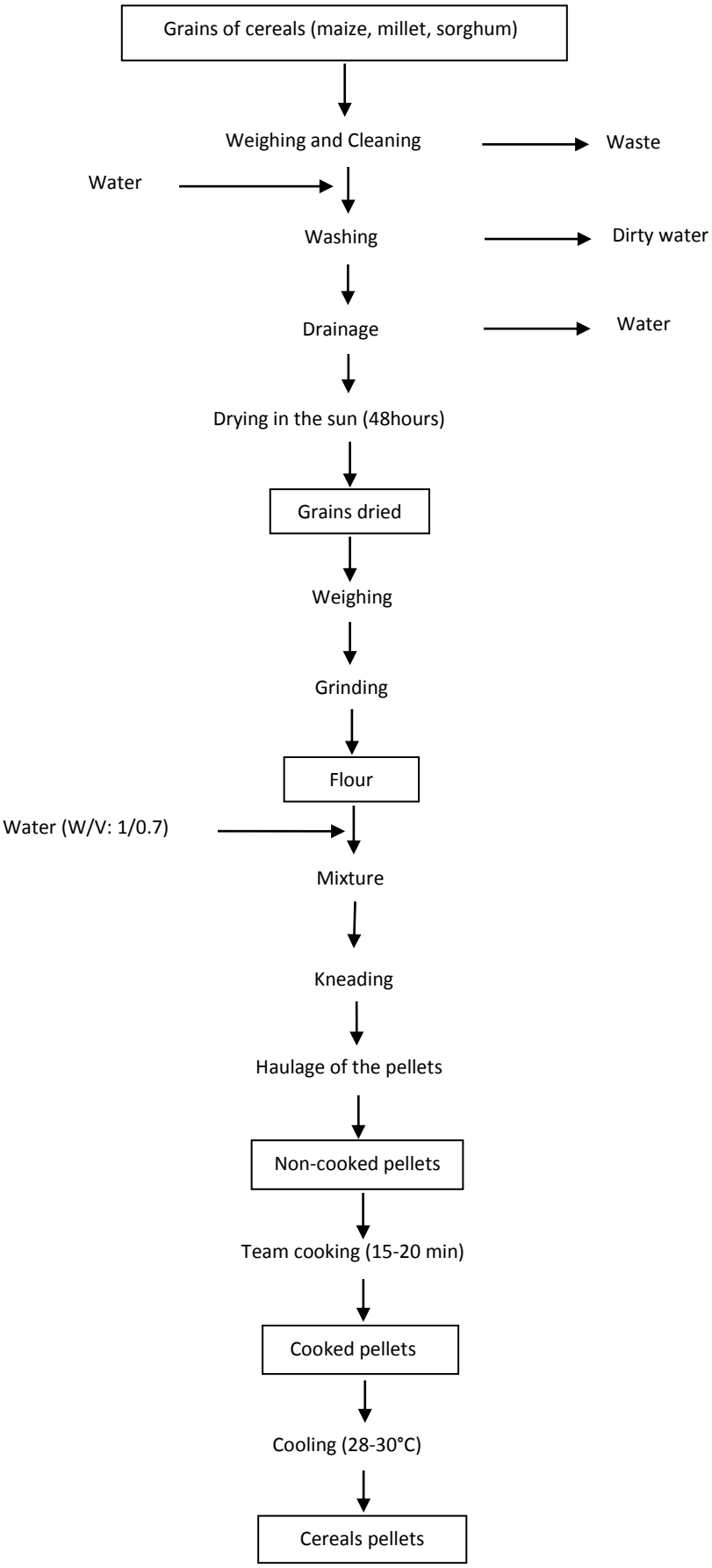

Figure 1: Technological diagram of production of cereals pellets

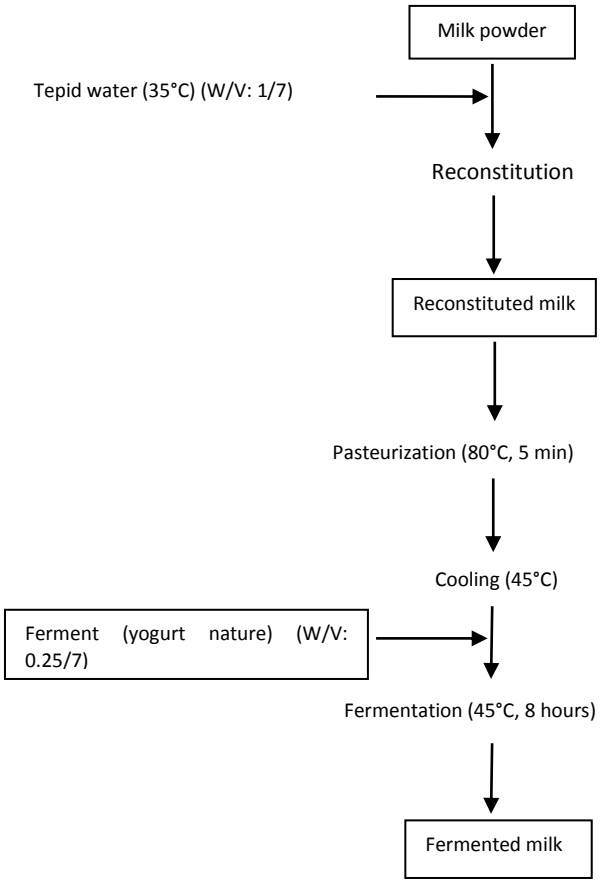

Figure 2: Technological diagram of production of fermented milk

The most important unit operation of the technological diagram of the production of the pellets is the haulage (Figure 1). It is essentially manual and tedious. Rolling called over know-how with respect to the adjustment of the size of the pellets, by adding water or by the intensity of mixing. This allows having pellets too soft, medium and acceptable sizes. This is a stage that determines the quality of dèguè. The finalized technology provides three types of pellets. It differs from the one traditionally known based millet flour described by Agbanzoume in 2005 [19] by the use of other flour.

Production of fermented milk

The results of production of fermented milk are shown in Figure 2.

Production of the three types of dèguè

The results of the technological manufacturing of the three types of dèguè are shown in Figure 3.

According to Figure 3, mixing and fermentation are the major operations of the manufacture of these types of dèguè. After experiments, the formula 25% of cereals pellets and 75% of fermented milk is adopted. All dèguè were prepared according to this formula which ensures the organoleptic characteristics necessary and acceptable in our finished products. The second fermentation which lasts 2hours provides thorough mixing and fermentation microorganism's revivification. Adding cereal products stimulates the growth of lactic acid bacteria during the second fermentation. This phase promotes the production of lactic acid to allow yeasts growth. This experiment was also made by Tchekessi *et al.* in 2013 [4].

Microbiological characteristics

The results of microbiological analysis of different types of dèguè are presented in Table 1.

Statistical analysis of microbiological results show that all values of p-value greater than 0.05 are obtained ($p > 0.05$). This study reveals that there is no significant difference at the 5% level between the three types of dèguè products (Table 1). Total mesophilic aerobic germs, yeasts and molds of each type are higher than the respective values 10^5/g and 10^2/g set by AFNOR for yoghurt. A difference can be explained by the incorporation of cereal pellets in fermented milk. As for the results of lactic acid bacteria, the values obtained are consistent with standards ($\geq 10^7$/g) set for yoghurt and

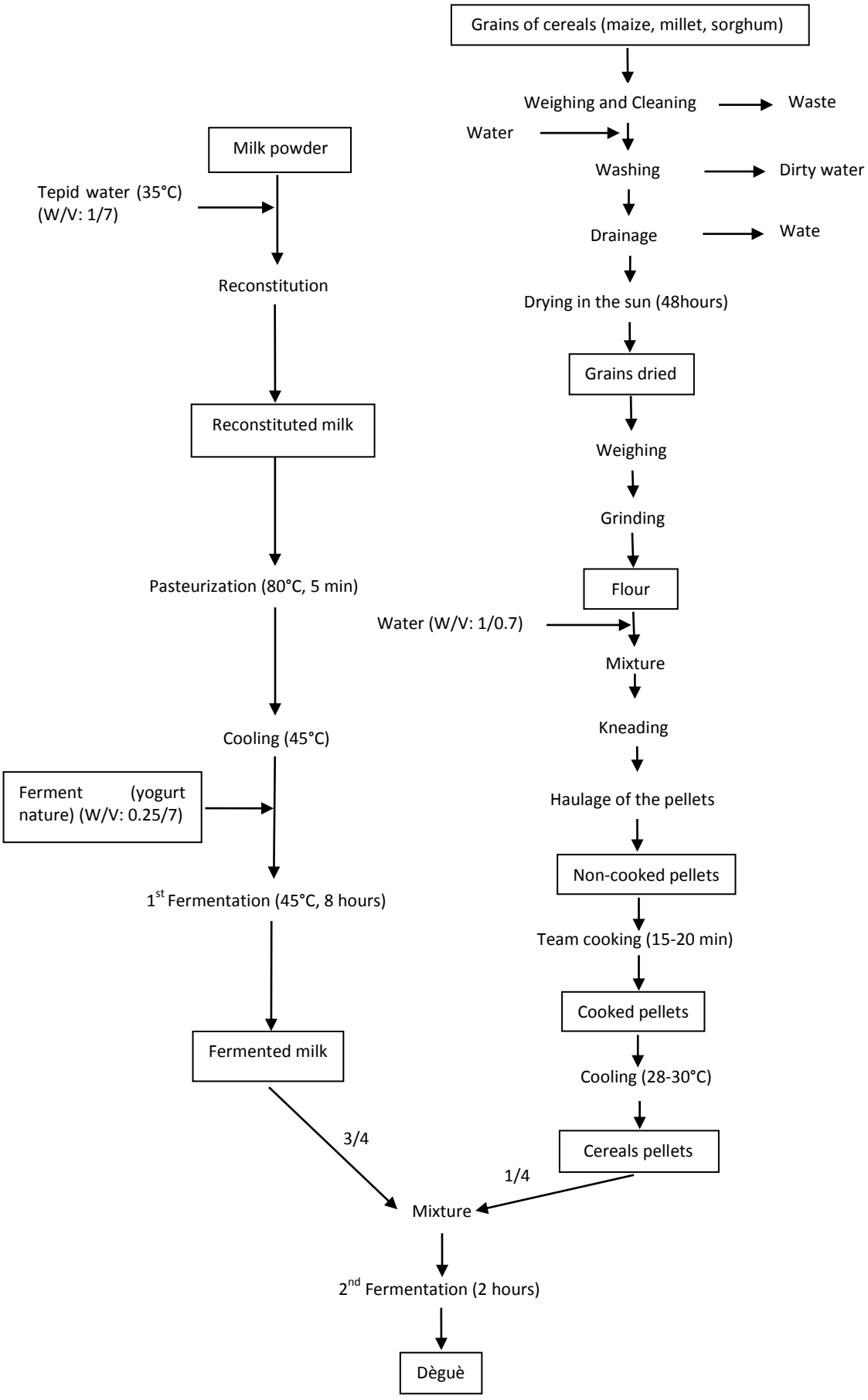

Figure 3: Technological diagram of production of three types of dèguè

Table 1: Microbiological characteristics of three types of dèguè

Types of Dèguè	Studied parameters						
	Total mesophilic flora (Log10CFU/g)	Yeasts and molds (Log10CFU/g)	Lactic acid bacteria (Log10CFU/g)	Total coliforms (Log10CFU/g)	Thermotolerant coliforms (Log10CFU/g)	*Staphylococcus aureus* (Log10CFU/g)	*Salmonella* (Log10CFU/g)
Dèguè Maïs	7.85±0.97[a]	8.44±0.86[a]	7.22±0.06[a]	<1[a]	<1[a]	<1[a]	Abs/25g
Dèguè Mil	7.31±0.19[a]	7.78±0.99[a]	7.49±0.02[a]	<1[a]	<1[a]	<1[a]	Abs/25g
Dèguè Sorgho	7.82±0.51[a]	7.91±0.38[a]	7.55±0.14[a]	<1[a]	<1[a]	<1[a]	Abs/25g
Norms of yoghurt (germs)	10^5/g	≤10^2/g	≥10^7/g	10/g	1/g	Abs/g	Abs/25g

In each of the columns, means of triplicate samples were recorded with different superscripts differ significantly (P < 0.05).
± Standard deviation; Abs: Absent.

(≥10^6/g) set for probiotic fermented milks by AFNOR NF V 04-600, 2001 cited by Beal and Sodini in 2003 [20]. Total and thermotolerant coliforms, *Staphylococcus aureus* and *Salmonella* did not grow after seeding. This shows that the production of three types of dèguè comply the standards of viewpoint hygienic quality and merchantability. Analysis of the results indicates overall that the dominant flora of dèguè is constituted of lactic acid bacteria and yeasts and molds. Therefore, the introduction of cereals flour dumplings would further enriched in milk fermented by lactic acid bacteria and yeasts and molds. These results are consistent with those obtained by Gymnase in 2011 [21] which states that cereals contain prebiotics which stimulate the growth of microorganisms in the case of bacteria. Indeed, lactic acid bacteria from their carbohydrate metabolism caused by acidification of the food become favorable to growth of yeasts and molds. Which acidification is the hygienic point of view a major asset because it prevents the growth of most pathogens (Tchekessi *et al.,* 2013) [4]. Thus, the preservative effect of lactic acid bacteria in the manufacture and storage of fermented foods is mainly acidic conditions they create, by converting carbohydrates into organic acids. These results are consistent with those of Mavhungu in 2006 [22].

Conclusion

This study allows us to finalize a technology for the production of three types of dèguè. The dominant flora of each type is lactic acid bacteria and yeasts and molds. The dèguè products contain no coliforms, *E. coli*, *Staphylococcus aureus* and *salmonella*. These manufactured products comply with the microbiological standards. Dèguè maize, dèguè sorghum and dèguè millet developed have great nutritional importance. They can be classified as probiotic foods because containing significant living cells capable to improve the intestinal flora of the consumer by giving it more immunity.

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