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Physico-chemical and sensory characterizations of three types of "dèguè", a local fermented drink made from milk in Benin

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Abstract

Dèguè is a fermented drink widely consumed in Benin and other countries of West Africa. Our study permitted to finalize three types of dèguè made from flours of maize, sorghum and millet, called respectively: dèguè maize, dèguè sorghum and dèguè millet. To increase consumer confidence and ensure their products good qualities, these three types of dèguè were evaluated and analyzed the physico-chemical and sensory plans. The results of analysis revealed that the three types of dèguè obtained contain iron, protein and sugar. All have an acidic taste with a pH below 4.3. Dèguè millet is richer in iron (38.32mg/100g) than the other two dèguès. Dèguè sorghum contains up to 21.59mg/100g, while dèguè maize contains only 18.21mg/100g. Dèguè maize is lightly richer in protein (13.95%) than dèguè mil (13.93%) and dèguè sorghum (13.64%). However, dèguè millet is sweeter (9.50%) than dèguè maize (6.47%) and dèguè sorghum (5.29%). Furthermore, all types of dèguè contain vitamins B1, B2 and C, however dèguè sorghum contains two more, it is of vitamins E and A of which the contents reach 6.76mg/100g and 8.69mg/100g respectively. Sensory analysis revealed that all three types of dèguè finalized accepted by the tasters. In view of these results, the consumption of dèguè sorghum is recommended.

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Introduction

Fermentation is one of the oldest technologies used for the manufacture and preservation of foods. It plays an important role in the improvement and diversification of taste and aroma of food. It is a technology upon which millions of people in the Third World use 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 food; they are mostly made from cereals, tubers or milk (Bokossa *et al.,* 2013; Tchekessi *et al.,* 2013; Banon, 2012).

In Benin, most fermented products are prepared with cereals (Bokossa *et al.,* 2013). These cereals are available throughout the country. They are primarily used in the food and consist mostly of maize, millet and sorghum (MAEP, 2010). 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 economy. Among these fermented cereal foods placed "dèguè".
Dèguè is a fermented drink made from milk and cereals flour. It is a foodstuff widely consumed in Benin and well beyond the West Africa. This food is sold in local markets, along the lanes, in public places, but also in schools and universities in Benin (Tchekessi *et al.,* 2014). According to these authors, it generates jobs of thousands of people especially women, whose level of education and skills in the manufacture and sale of dèguè are limited. The present study essentially aims to finalize three types of dèguè of better qualities, but that have never been scientific studies in the West African sub-region.

Material and methods

Collection of raw material

Maize (*Zea mays L*), millet (*Pennisetum glaucum*) and Sorghum (*Sorghum bicolor*) purchased at local market of Abomey-Calavi were three cereals used for this study.

The plain yogurt composed of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* was bought at the pharmacy Togoudo (Abomey-Calavi) for fermentation dèguè.

Milk powder brand LACSTAR of Irish origin bought at the market in Cotonou at Dantokpa served animal material.

The water from the National Water Company of Benin (SONEB) recognized drinkable by service of water quality of the Ministry of Mines and Water of Benin was used during the production of different types of dèguè.

Dèguè production

The three types of production of dèguè were made according to the technology of Figure 1.

Evaluation of the physico-chemical quality

Physico-chemical analyzes were conducted to know the pH, titratable acidity, moisture content, ash, iron, crude protein, total sugars and vitamins on the three types of dèguè.

Determination of pH and titratable acidity

The pH and titratable acidity were determined by the modified method of Nout *et al.* (1989). Ten (10) grams of dèguè sample were homogenized in 20ml of distilled water in a beaker. The pH of the mixture was determined manually, using INOLAB 730 pH meter provided with a probe.

The sample whose pH has been determined was transferred into 100ml conical flask and 70ml of distilled water was then used to wash out the beaker into the flask. The suspension was then filtered against 0.1M NaOH using phenolphthalein (1%). The total titratable acidity was calculated as percentage lactic acid.

Moisture content analysis

The moisture content and dry matter content were determined by AACC method (1984) from 5 g of product, by drying and by differential weighing. Thus, five (5) grams of each sample were accurately weighed

into a cleaned, dried and weighed glass Petri-dishes. These dishes with their content were placed inside the steamroom hot air oven at a temperature of 105°C for 72h. Hereafter, they were cooled in desiccators and weighed.

Analysis of minerals

The ash content was determined from the dry matter by calcinations at 550°C for 24 hours according to the method of AACC (1984). 5 g of samples of dèguè were weighed out into beakers and incinerated at 550˚C overnight.

The iron was determined by Atomic Absorption Spectrophotometer (AAS) as per the standard method. Thus, the resulting ash residue was dissolved in 4 mL of concentrated hydrochloric acid and filtered into a 10 mL volumetric flask and the volume made up with distilled water. The resulting extract was then subjected for the analysis of their content of iron.

Protein content

The protein content (N x 6.25) was determined by the micro Kjeldahl method according to AACC, 1984. Following this procedure, nitrogen percentage was estimated. The protein was calculated by multiplying percent nitrogen with conversion factor, 6.25.

Analysis of total sugars

The total sugars were determined according to phenol sulfuric acid method (Dubois *et al.,* 1956). A standard curve was obtained using the following concentration of sucrose in (mg/ml) 2.5, 2.0, 1.25, 1.0, 0.5 g of each sample with 9 ml of distillated water was measured into test-tube. 2 ml of phenol solution (1%) and 1 ml of H_2SO4 (98.07%) solution were added. This was shaken for 15 min and boiled at 100°C for 30 min. It was then allowed to cool and absorbance was read using spectrophotometer (spectrum lab 22) at 700 nm. The sugar concentration was then obtained by extrapolation from the standard curve.

Determination of vitamins

Vitamins A, C, E and K1 were determined by High Performance Thin Layer Chromatography (HPTLC).

Vitamins A, E and K1 were determined carried out on an aliquot by measuring absorbance at 254nm with densitometer Camag TLC Scanner III. Standard curves made with pure vitamin A, vitamin E and vitamin K1 were used for this purpose and the results expressed as mg vitamin A equivalent, mg vitamin E equivalent or mg vitamin K1 equivalent per 100 g dèguè sample.

Vitamin C was evaluated after derivation that consists in extracting the hydrazones. This derivation has been applied to the samples as well that to the standard solution. It was determined carried out on an aliquot by measuring absorbance at 360 nm with densitometer Camag TLC Scanner III. A standard sample of ascorbic acid was used as reference and the results expressed in mg vitamin C/100g of dèguè.

Vitamins B1 and B2 were analyzed by reversed phase HPLC with detection in UV by a spectrophotometer to biretta of diodes as previously described by Benmoussa *et al.,* 2003. All analyses were performed in triplicate and the average of the values obtained was considered.

Sensory evaluation of three types of dèguè

Sensory analysis was performed according to the methods of comparison described by Larmond (1977) quoted by Bokossa *et al.* (2011). A panel of tasters consisting of 33 people, consumers and professionals of dèguè was established. They were randomly selected and trained for the purpose. The test objective is to identify the differences between the various types of dèguè and know the consumer preference. Tested parameters are: color, taste, acidity, aroma (smell), texture (consistency), overall acceptability and preference. Each treatment was evaluated three times by each panelist.

Statistical analysis

All data collected from analysis 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

Results

Physico-chemical characteristics of the grains and flours of cereals

The moisture content of the grains and cereals flours used in the production of dèguès is given in Table 1. The moisture contents of maize grains, millet and sorghum were respectively 13.00%, 13.40% and 12.60%. However, the ones of maize flours, millet and sorghum were respectively 10.30%, 11.20% and 10.70%. In spite of the highest moisture contents of millet samples, the statistical analysis revealed that there is no significant difference at the 5% level between moisture content of three cereals grain and between the three types of flours.

Table 1. Physico-chemical characteristics of the grains and flours of cereals.

Samples of Cereals	Moisture content (%)		P-value
	Grains	Flours	
Maize	13.000±0.283[a]	10.300±0.141 [a]	0.053
Millet	13.400±1.131[a]	11.200±0.565 [a]	0.246
Sorghum	12.600±0.001[a]	10.700±2.969 [a]	0.532
P-value	0.561	0.880	

Mean values with the same letter on the same line and in the same column are not significantly different at the 5% level. Data represents in table is mean of three replications. ± Standard deviation.

Physico-chemical characteristics of the pellets

Table 2 presented the results of physico-chemical analyzes of the pellets used in the preparation of dèguès. This table 2 showed that the millet pellets had the highest (56.400%) dry matter, followed by sorghum (47.000%) and maize (46.500%) pellets. Ash contents were respectively 0.604%, 0.485% and 0.431% for pellets from millet, sorghum and maize. In addition, iron contents were 13.397mg/100g for millet pellets and respectively 11.530mg/100g and 3.610mg/100g for sorghum and maize pellets. Millet pellets presented the highest content in ash and iron. Likewise, this sample indicated the highest (7.885%) total sugar rate, followed by maize pellets (4.812%) and sorghum (4.435%) pellets. On the other hand, sorghum pellets were riches in protein (10.123%) that the ones of millet (8.490%) and maize (8.087%). Statistical analysis showed that there is a significant difference at 5% between protein ($p = 0.003$), ash content ($p = 0.031$), total sugar ($p = 0.000$) and between iron ($p = 0.000$) of three types of cereals pellets. But, there is no significant difference between dry matter rate ($p = 0.244$) of the three samples.

Table 2. Physico-chemical characteristics of pellets.

Samples of pellets	Studied parameters					
	Dry matter (%)	Ash (%)	Iron (mg/100g)	Nitrogen N (%)	Proteins N x 6.25 (%)	Total sugars (%)
Maize	46.500±0.989[a]	0.431±0.025[a]	3.610±1.395[b]	1.294±0.028[a]	8.087±0.176[a]	4.812±0.011[a]
Millet	56.400±3.111[a]	0.604±0.052[b]	13.397±0.172[a]	1.359±0.031[a]	8.490±0.197[a]	7.885±0.109[b]
Sorghum	47.000±5.232[a]	0.485±0.009[a]	11.530±0.192[a]	1.619±0.030[b]	10.123±0.190[b]	4.435±0.022[a]
P-value	0.244	0.031	0.000	0.003	0.003	0.000

Mean values with the same letter in the same column are not significantly different at the 5% level.
Data represents in table is mean of three replications. ± Standard deviation.

Physico-chemical characteristics of three types of dèguè

The results of the physico-chemical parameters of types of dèguès are shown in Table 3. The three samples of dèguè had a pH lower than 4.3. Their acidity rate varied between 1.050 and 1.800%. Dèguè millet had the highest (22.200%) dry matter rate, followed by dèguè sorghum (21.200%) and

dèguè maize (20.100%). In addition, ash contents were respectively 0.744%, 0.753% and 0.720% for dèguè millet, dèguè sorghum and dèguè maize. Dèguè millet appeared richer in ash than dèguè sorghum and dèguè maize. It contained more iron (38.320mg/100g) than dèguè sorghum (21.590mg/100g) and dèguè maize (18.210mg/100g). This sample also indicated the highest (9.501%) total sugar rate, followed by dèguè maize (6.470%) and dèguè sorghum (5.291%). However, dèguè maize was lightly richer in protein (13.950%) than dèguè millet (13.930%) and dèguè sorghum (13.640%). Statistical analysis showed that there is no significant difference at 5% between dry matter rate (p = 0.716), ash content (p = 0.423) and between protein (p =0.334) of dèguès. By cons there is a significant difference between iron (P = 0.001) and total sugar rate (p = 0.000) of three samples.

Table 3. Physico-chemical characteristics of three types of dèguè.

Types of Dèguè	Studied parameters							
	pH	Dry matter (%)	Ash (%)	Iron (mg/100g)	Nitrogen (%)	N Proteins N x 6.25 (%)	Total Sugars (%)	Titratable acidity (%)
Dèguè Maize	4.210± 0.098[a]	20.100± 2.404[a]	0.720±0.00 0[a]	18.210± 0.435[a]	2.233± 0.031[a]	13.950± 0.195[a]	6.470± 0.018[a]	1.050± 0.212[a]
Dèguè Millet	4.270± 0.035[a]	22.200± 1.979[a]	0.744± 0.029[a]	38.320± 1.745[b]	2.229± 0.031[a]	13.930± 0.195[a]	9.501± 0.091[b]	1.350± 0.636[a]
Dèguè Sorghum	4.220± 0.007[a]	21.200± 2.828[a]	0.753± 0.023[a]	21.590± 1.220[a]	2.183± 0.031[a]	13.640± 0.195[a]	5.291± 0.183[a]	1.800± 0.000[a]
P-value	0.593	0.716	0.423	0.001	0.337	0.334	0.000	0.293

Mean values with the same letter in the same column are not significantly different at the 5% level. Data represents in table is mean of three replications. ± Standard deviation.

Vitamin content of the three types of dèguè

The vitamins content (A, B1, B2, C, E and K1) of different samples of dèguè were indicated in Table 4. Thus, dèguè sorghum (8.695mg/100g) and dèguè maize (8.560mg/100g) presented higher vitamins A rate than dèguè millet (traces). Dèguè millet is richer in vitamins B1 (0.290mg/100g) than dèguè maize (0.250mg/100g) and dèguè sorghum (0.250mg/100g). In addition, dèguè millet contained more vitamins C (38.380mg/100g) than dèguè maize (11.100mg/100g) and dèguè sorghum (10.155mg/100g). On the other hand, dèguè maize is richer in vitamin B2 (0.560mg/100g) than dèguè millet (0.380mg/100g) and dèguè sorghum (0.370mg/100g). Alone dèguè sorghum contained an important part of the vitamin E (6.760 mg/100g). Vitamins K were in traces in all samples. Statistical analysis revealed that there is a significant difference at 5% between the vitamins A (p = 0.001), vitamins C (p = 0.001) and between vitamins E (p = 0.000) of the three types of dèguè. But there is no significant difference between vitamins B1 (p = 0.625) and vitamins B2 (0.076) of dèguès.

Table 4. Vitamins composition of different dèguès.

Types of Dèguè	Vitamins (mg/100g)					
	A	B_1	B_2	C	E	K_1
Dèguè Maize	8.560±0.297[a]	0.250±0.028[a]	0.560±0.056[a]	11.100±1.767[a]	traces[a]	traces[a]
Dèguè Millet	traces[b]	0.290±0.056[a]	0.380±0.042[a]	38.380±1.032[b]	traces[a]	traces[a]
Dèguè Sorghum	8.695±0.955[.a]	0.250±0.042 [a]	0.370±0.071[a]	10.155±2.45[a]	6.760±0.226[b]	traces[a]
P-value	0.001	0.625	0.076	0.001	0.000	-

Mean values with the same letter in the same column are not significantly different at the 5% level. Data represents in table is mean of three replications. ± Standard deviation.

Sensory characteristics

Figure 2 presented the results from sensory evaluation of different types of dèguès. It showed that dèguè maize and dèguè sorghum were more acid than dèguè millet. Dèguè maize was sweeter than the two other samples. However dèguès based of millet and sorghum had a color and an odor more pleasant than the one of maize. These two types of dèguè had better consistency and were more accepted than dèguè maize. Although, the three products were accepted globally by the tasters, they had more prefer dèguè millet.

Discussion

Statistical analysis of the results of the moisture content of cereals and flours shows that there is no significant difference between the moisture content of grain and flour (Table 1) at 5% level. The grains of maize used for this study have a water content of 13%. This is consistent with that obtained by Aho and Kossou (1997) and Fandohan *et al.* (2005). Moisture contents of sorghum grains are higher than those obtained (10.56 and 9.85%) by Konfo *et al.* (2014). The moisture content of grains and flours are close to the standard content (about 10%) of dried foods. They preserve these grains and flours of the microbial contaminations. Thus, the gotten contents provide good conservation of the food. Indeed, the availability of water (water activity, aw) influences metabolic activities and therefore the life of the microorganisms. The results of physico-chemical analyzes show that pellets millet flour are richer in dry matter (56.40%), ash (0.604%), iron (11.97mg/100g) and total sugars (7,885%) than pellets of maize and sorghum (Table 2). The wealth of iron pellets is justified by the high iron content of millet grains. These results are consistent with those gotten by FAO (1970) cited by Koné (2011). According to this author the millet contains more iron (20.7g/100g) than the maize and sorghum. On the other hand, sorghum flour pellets are richer in protein (10.26%) than the other two cereals pellets. This difference is explained by the fact that sorghum grains according to the work done by FAO (1970) cited by Koné (2011) are richer in protein (11%) than maize grain (10.6%) and millet (9.5%).

The physico-chemical analyzes of types of dèguè show that all samples have a pH below 4.3 (Table 3). This inhibits further development of pathogens in these foods. Adjigbey-Tasas (2003) has also shown that below pH 4.5 all life becomes impossible for these kinds of microorganisms. Statistical analysis of the types of dèguè shows that dèguè millet is richer in total sugars and iron than dèguè based maize and sorghum. However, there is no significant difference between the pH, protein levels, titratable acidity, dry matter and ash content of the three types. In contrast, the total sugar content differs from one variety into another. This difference can be explained by the fact that the three types of cereals are different.

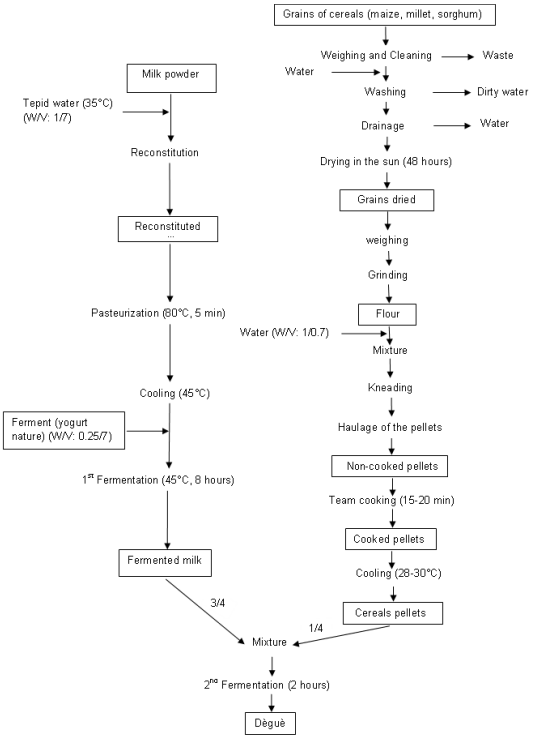

Fig. 1. Technological diagram of production of three types of dèguè.

The dosage of vitamins reveals that all types of products dèguè contain vitamin B1, B2 and C (Table 4). While alone dèguè sorghum contains 6.76mg/100g of vitamin E. Except dèguè millet, other types such as fermented products contain in addition to the vitamin A. However, dèguè millet is richer in vitamin C than dèguè sorghum and dèguè maize. These vitamins proceed from cereals and fermented milk and are essential for the efficient working of the body. These results are consistent with those of

Jeantet *et al.,* 2008. According to these authors, vitamins A, B1, B2, C and E can be found in yogurt and intervene especially for the efficient working of metabolism on a level with the production of energy (vitamins B1 and B2), of the eyes and skin (vitamin A). Vitamins C and E have antioxidant actions and thus preserve more foodstuffs that contain them.

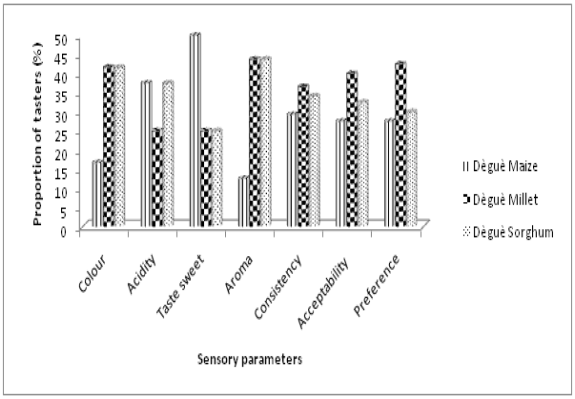

Fig. 2. Comparison of different sensory parameters of the three types of dèguè.

According to the results of sensory tests (Fig. 2), it appears that dèguè maize and dèguè sorghum are more acidic than dèguè mil. Tasters better appreciate the color and smell of dèguè sorghum, but they preferred dèguè millet, because this choice is justified by the food used in Benin, where it is known that this type of dèguè. There is almost no literature on production and sensory analysis of dèguè maize and dèguè sorghum. However, tasters generally accepted three products.

Conclusion

This study permitted to finalize three types of dèguè of good quality. However, given the wealth of nutrients dèguè sorghum and availability throughout the territory of sorghum, it would be better industrial production dèguè based sorghum. We therefore recommend its consumption especially for pregnant women, children and the elderly.

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