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Characteristics of baobab pulp-based foods from urban areas of Benin

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Abstract

Baobab is a multipurpose tree, with nutritional importance to African rural populations, and several products are derived from its fruit. The dehulled fruit delivers a pulp used for food processing. The present study aimed to characterize the baobab pulp derived products encountered in food outlets in Benin. Pulp based foods were inventoried and characterized for their physico-chemical composition, through the determinations of pH, Brix value, dry matter, color and their microflora, through the mesophilic aerobic germs and the enterobacteriaceae. The pH, Brix value, dry matter and color were assessed using potentiometric, refractometric, gravimetric methods, and the chromameter respectively; the microflora was evaluated by colony count method. Surveying the food outlets of the four dominant cities, nectars, syrups and pulp were noticed as the main baobab fruit pulp products commercialized. The pH, Brix value, dry matter of these foods, ranged between 3.3-3.7, 5.7-20.9 °Bx and 6.7-19.4 g/100g for nectars, 3.3-3.5, 58-69 °Bx and 52-58 g/100g for syrups, and 3.3-3.4, 54.5-61.5 °Bx, 84.0-90.8 g/100g for pulps. The color was orange for nectars, red for syrups and from orange to yellow for pulp, based on their hue value. Mesophilic aerobic germs and Enterobacteriaceae count in pulps ranged from 3.4-5.0 log CFU/g and <1-3.2 log CFU/g respectively. The baobab pulp derived products, namely the nectar, the pulp and the syrup, possess a strong variability in their quality, and the understanding of the processing and storage techniques will contribute to develop suitable technologies for each baobab pulp derived product.

Key words : Nectar, syrups, pulp, color, microflora

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Caractéristiques des aliments dérivés de la pulpe de baobab des centres urbains du Bénin

Résumé

Le baobab est un arbre à usage multiple, nutritionnellement important pour les populations rurales africaines; plusieurs produits sont obtenus de ses fruits. Le fruit décortiqué fournit une pulpe utilisée pour la transformation de nombreux aliments. La présente étude a visé la caractérisation des produits dérivés de la pulpe de baobab rencontrés dans les points de vente alimentaire au Bénin. Ces aliments ont été inventoriés et caractérisés pour leur composition physico-chimique, à travers le pH, le degré Brix, la matière sèche, la couleur, et leur microflore, dont les germes aérobies mésophiles et les entérobactéries. Le pH, le degré Brix, la matière sèche et la couleur ont été évalués respectivement avec des méthodes potentiométriques, réfractométriques, gravimétriques et du chromamètre; la microflore a été évaluée par la méthode du comptage des colonies. L'analyse des données collectées des points de vente d'aliments dans les quatre grandes villes du Bénin a révélé que les nectars, les sirops et la pulpe étaient les principaux produits de pulpe de fruits de baobab. Le pH, le degré Brix, la matière sèche de ces aliments, variaient respectivement entre 3,3-3,7, 5,7-20,9 °Bx et 6,7-19,4 g/100 g pour les nectars, 3,3-3,5, 58-69 °Bx et 52-58 g/100g pour les sirops, et 3,3-3,4, 54,5-61,5 °Bx, 84,0-90,8 g/100g pour les pulpes. Sur la base de la valeur de la teinte, les pulpes, nectars et sirops étaient respectivement de couleur jaune-orange, orange et rouge. Les charges en germes aérobies mésophiles et en entérobactéries dans les pulpes variaient de 3,4 à 5,0 log UFC/g et de <1 à 3,2 log UFC/g respectivement. Le nectar, la pulpe et le sirop de baobab commercialisés au Bénin, présentent qualitativement une forte variabilité ; la compréhension des techniques de transformation et de stockage contribuera à développer des technologies appropriées pour chaque produit dérivé de la pulpe de baobab.

Mots clés : Nectar, Sirops, Pulpe, Couleur, Microflore

INTRODUCTION

Adansonia digitata, a tree encountered in African savannas, is a multipurpose tree whose leaves, seeds and pulp are consumed widely by rural populations in Africa (Assogbadjo et al., 2008). The baobab fruit pulp also has numerous nutritional and medicinal potentials. Indeed Baobab pulp contains high antioxidant capacity estimated at 10.8 mmol/100g (Carlsen et al., 2010; Hamad, 2019) and is rich in vitamin C, about 209 to 360 mg/100g (Chadare et al., 2009). The mineral content reported for the pulp were: 1794 – 2220 mg/100g dw for potassium, 302 – 430 mg/100g dw for calcium, 195 – 230 mg/100g dw for magnesium, 14.8 – 100 mg/100g dw for sodium, 106 – 110 mg/100g dw for phosphorus, 4.3 – 5.74 mg/100g dw for iron and 0.7 – 2.72 mg/100g dw for manganese (Chadare et al., 2009; Muthai et al., 2016). It is used to improve the bioavailability of minerals (iron and zinc), and also used as an ingredient for food-to-food fortification of pearl millet (van der Merwe et al., 2019). Baobab pulp also has functional compounds as hydroxycinnamic acid glycosides, reported to have anti-inflammatory, anti-carcinogenic, antimicrobial properties, iridoid glycosides and phenylethanoid glycosides, reported to have antiviral, antimicrobial, antioxidant and anti-inflammatory properties (Li et al., 2017). The pulp also contains phytochemicals as flavonol glycosides, procyanidins (Braca et al., 2018), which contribute to reducing triglycerides content (Althwab et al., 2019) in hyperlipidemic rats' bodies after consuming aqueous baobab pulp extract (10% v/v).

Diverse products were derived from the baobab pulp. Indeed, it is used in the processing of many foods as the porridges, the sauce and creams; it is also used to coagulate milk, activate the alcoholic fermentation of juice or cereals' beer (Diop et al., 2006). Among the derived products, the fruit pulp nectar appears as the most investigated product in countries as Senegal (Cissé et al., 2009), in Ivory coast (Ambé, 2001) and in Namibia (Lisao et al., 2017). In Benin, around eleven products derived from the pulp were reported by Chadare et al. (2013) at the traditional scale; these products are the gruel, "Moukou-Moukou", the fermented sourdough called "Mutchayan", "Nanganfirou", "Yewowi" beverage, "Solani", "Tcho" beverage, the pulp beverage, the iced pulp beverage, "Norendoorou" and the baobab pulp syrup. Although the valorization and promotion of these traditional products will contribute to improving local populations' income and health status due to the above-mentioned properties of the pulp, most of these products are still not present in food distribution areas in Beninese cities.

Moreover, few studies were realized on these derived products. Some products as the pulps were submitted to preliminary studies for the evaluation of the characteristics of baobab pulp in different markets in Abidjan (Ivory coast) (Pamba et al., 2018) through the assessment of physico-chemical characteristics, macronutrients and micronutrients contents (Vitamin C, minerals and oligo-elements). The nectar was also investigated in terms of the variation of physico-chemical parameters (Cissé et al., 2009), of bioactive compounds (Tembo et al., 2017); but few research focused on the diversity and the characterization of other derived products produced and commercialized. Furthermore, the baobab pulp derived products encountered in food outlets of Benin were not investigated so far.

This study assessed the diversity and the quality of baobab pulp derived foods commercialized in the food outlets found in Benin cities.

MATERIAL AND METHOD

Material

Baobab pulp and its derived products were purchased in urban-food outlets. They were stored at the laboratory, in the refrigerator (4 °C) for liquid products, and in their packaging at room temperature (around 20 °C) for solid products until analyses, within seven days.

Method

Experimental design

The experimental design consisted in the identification of baobab fruit pulp derived products available in the market, followed by the characterization of the most processed ones (Figure 1). The identification of Baobab fruit pulp derived products was realized through a field survey performed in four of the most populated cities in Benin, namely Cotonou, Abomey-Calavi, Porto-Novo and Parakou. During this survey, a systematic listing of baobab fruit pulp foods was realized by visiting supermarkets, shops, pharmacies and restaurants. Collected data on each product include brand, nature of product, type of packaging, and ingredients. Each identified brand product was purchased once and transported to the laboratory for analyses. At laboratory, nectars, pulps and syrups were analyzed for assessment of pH, Brix degree, dry matter, color (physico-chemical analyses), and pulp samples were investigated for total viable count and Enterobacteriaceae count (microbiological analyses); microbiological analyses were assessed only on the pulp, due to limited resources available.

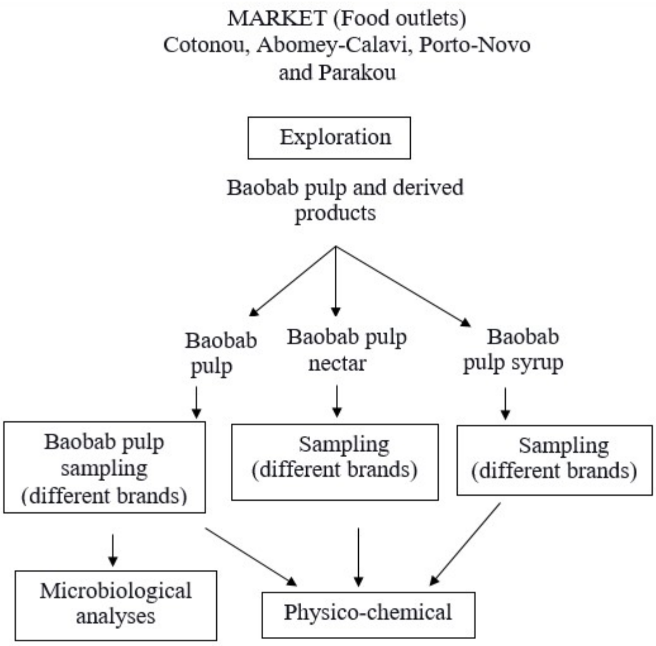

Figure 1: Experimental design

Physicochemical analyses

The pH were determined with a pH meter (Cyberscan pH 510, EUTECH Instruments, Malaysia), according to EAS 41-5:2000 (ISO, 1991), using the potentiometric method. The dry matter were assessed according to AOAC International (1980) (Association of Official Analytical Chemists) following the gravimetric method, and using an oven

(VENTI-Line, VWR, Germany), at 105°C for 3 days. The Brix values were determined using a digital refractometer 0-54 Bx/1.33-1.42 RI (VWR, Leuven, Belgium) according to ISO 2173:2003 (ISO, 2003). The Brix value of syrups was determined, after adding 25 g of distilled water to 25 g of syrup's sample; for pulp, however, it was assessed after adding 25 g of distilled water to 5 g of the sample. The Brix value of nectars was read directly on the refractometer while it was calculated for syrups and pulp using the formula (1), as indicated in the used standard (ISO, 2003) and is expressed in °Bx.

$$Brix = \frac{P \times M_1}{M_0} \quad (1)$$

with "P", the mass fraction of soluble solids in the diluted solution, in percent;

"M0"", the mass of the sample before dilution;

"M1", the mass of the sample after dilution.

The color of the nectars, syrups and the pulp, was determined using a chromameter CR410 (Konica Minolta, Optics, Inc., Japan), illuminant D-65. The color was expressed through the lightness (L*), the redness (a*), the yellowness (b*) and the total difference of color (ΔE*) in CIELAB color space, with the blank standard as the reference (L*=95.0, a*= -0.58 and b*= 4.43). The hue (H* in degree) and the chroma (C*) were calculated as follows (Minolta, 2003):

$$H^* = Arctan\left(\frac{b*}{a*}\right) \qquad C^* = \sqrt{a^{*2} + b^{*2}}$$

Microbiological analyses

Microbiological quality was assessed only on the collected baobab pulp samples. Ten grams of each collected baobab pulp brand's sample was introduced into 90 ml of the sterile buffered peptone water solution and homogenized with a Stomacher Lab Blender for 30 seconds to obtain dilution 10-1. From the dilution 10-1, ten-fold serial dilutions were prepared in the sterile buffered peptone water solution. In Petri dishes, a volume of 1 ml of each ten-fold serial dilution was added, and the pre-cooled agar medium (20 ml), at 45 °C was poured in, mixed to the inoculum, and allow to solidify. The total viable count was determined on Plate Count Agar (PCA) medium (VWR Chemicals, PROLABO) incubated at 30 °C for 72 h, according to the standard ISO 4833-1:2013 (ISO, 2013). The Enterobacteriaceae count was determined using Violet Red Bile Glucose (VRBG) medium (VWR Chemicals, PROLABO) incubated at 37 °C for 24 h, according to the standard BS ISO 21528-2:2004 (ISO, 2004).

Data Analysis

Data from the field survey and laboratory assays were analyzed using XLSTAT 2016 software. For the nectars' characterization, a Principal Component Analysis (PCA) was drawn on physicochemical data. An agglomerative hierarchical cluster analysis was performed on the color parameters, based on Euclidean distance as dissimilarity and Ward method as aggregation method; the truncation considered varied from 3 to 8, and the number of classes chosen depended on the final number of classes which limited the inter-class variance.

The Shapiro-Wilk test was performed for assessing normality and the Levene test for homoscedasticity on color data. For the data with a non-normal distribution and heteroscedasticity, a variable transformation was done using the optimized function of "Box-Cox". When Anova prerequisites are met (L*, H*and C* of nectars), a one-way ANOVA test was applied to assess the color variability according to the classes. The Student-Newman-Keuls (SNK) test was used to make pairwise comparisons for the chroma and total color difference (for syrups). In case the normality and homoscedasticity conditions are not observed, after a box-cox data transformation, the Kruskal-Wallis test was realized to evaluate the color variability and the Dunn's test as a post-hoc test. The concerned variables were related to the baobab pulp (L*, H*, C* and ΔE*), to syrups (L*, H*), and pasteurized baobab pulp nectars (ΔE*).

RESULTS

Diversity of baobab fruit pulp-based products and their ingredients

From 256 food outlets investigated that distribute baobab-based foods, 132 (51.6%) were located in Cotonou, 55 (21.5%) in Abomey-Calavi, 40 (15.6%) in Porto-Novo and 29 (11.3%) in Parakou. Eight categories of foods were recorded. These categories are pastils, the most frequently encountered (nearly 48.8% of the registered products), nectars (about 29.3%), the pulp (about 11.7%), syrups (about 5.5%), cocktails (about

2.7%), biscuits (about 1.2%), cakes (0.4%) and infant flours (0.4%). Nectars, pulp and syrup are produced by 55%, 20% and 10% of processing units (80 processing units recorded) respectively.

Baobab pulp products were encountered in pharmacies, supermarkets, small shops and stores of processing units. The pastils are the main products and represented in 94% of pharmacies of the four cities investigated with a single brand encountered everywhere (for a total of 97 pharmacies recorded), followed by the pulp which is represented in 6% of pharmacies. The nectars are the main in supermarkets and other food outlets (nectars are found in 47% of 160 food outlets) with 19 brands recorded in Cotonou and 15 brands found in Abomey-Calavi; nectars are absent in pharmacies.

Different ingredients are used in the production of baobab fruit pulp derived products by the processing units in Benin. The ingredients used for nectars and syrups are baobab fruit pulp, sugar, and water. The ingredients used for cocktails are baobab fruit pulp, pineapple (Ananas comosus) fruit juice or aqueous bissap (Hibiscus sabdarifa) extract or lemon (Citrus limon) juice. Packages used for nectars, syrups, and cocktails are glass bottles (uncolored, or with a green or a chestnut colors) and polyethylene bottles, for liquid products. Solid products are packed in polyethylene, polypropylene, polyethylene high-density packagings or cardboard packages.

Physicochemical and microbiological characteristics of baobab pulps, syrups and nectars

The baobab pulps commercialized in Benin are acidic, with a pH of 3.3 to 3.4. Their Brix values ranged from 54.5 to 61.5 °Bx and their dry matter content from 84.0 to 90.8 g/100g (Table 1). The pasteurized baobab nectars were acid and their pH ranged from 3.3 to 3.7 (Table I); their Brix value and dry matter ranged from 5.7 to 20.9 °Bx and 6.7 to 19.5 g/100g respectively. The syrups had their pH ranging from 3.3 to 3.5, their Brix values from 58 to 69 °Bx and their dry matter from 52 to 58 g/100g (Table 1).

The assessment of the microbiological quality of these baobab pulps revealed that the total viable count ranged from 3.4 to 5.0 log CFU/g and Enterobacteriaceae count from less than 1 to 3.2 log CFU/g (Table 2). The principal component analysis on the Brix, pH and dry matter variables of pasteurized pulp nectars revealed that the two first principal components were sufficient to explain 99.3% of the information contained in the data.

The dry matter and Brix variables were highly correlated with the first component (F1), while the pH variable was highly correlated with the second component (F2) (Figure 2). The analysis revealed that 30.8% of the pasteurized baobab pulp nectars produced in Benin are the sweetest (17.6±2.3 °Bx) and had a high dry matter (16.3±2.1g/100g), in comparison to other nectars; 23.1% were the least sweet (9.5±8.0 °Bx) of pasteurized baobab pulp nectars, with low dry matter (9.7±3.8g/100g). Twenty-three percent (23.1%) of the nectars had the highest pH (3.5±0.1), while 23.1% had the lowest (pH=3.3±0.0).

Table 1: Physical properties of baobab pulp, pasteurized nectars and syrups

Products		pH	Brix (°Bx)	Dry matter (g/100g)
Pulp	Mean (n=9)	3.34	58	86.92
	CV (%)	2.28	3.38	2.46
Nectar	Mean (n=26)	3.42	14.15	13.51
	CV (%)	3.1	26.4	21.7
Syrup	Mean (n=4)	3.34	61.25	55.05
	CV (%)	2.9	6.9	3.9

CV: variation's coefficient of different brands' nectars. n: number of brands (sample) considered

Table 2: Microbiological quality of Baobab pulp

Pulp Brands (P)	Total viable count (log cfu/g)	Entobacteriaceae (log cfu/g)
P1	3,98	3,24
P2	4,95	2,70
P3	4,37	< 1
P4	3,71	3,14
P5	3,64	3,10
P6	4,71	2,71
P7	3,38	2,02
P8	4,32	2,87
P9	4,99	3,01

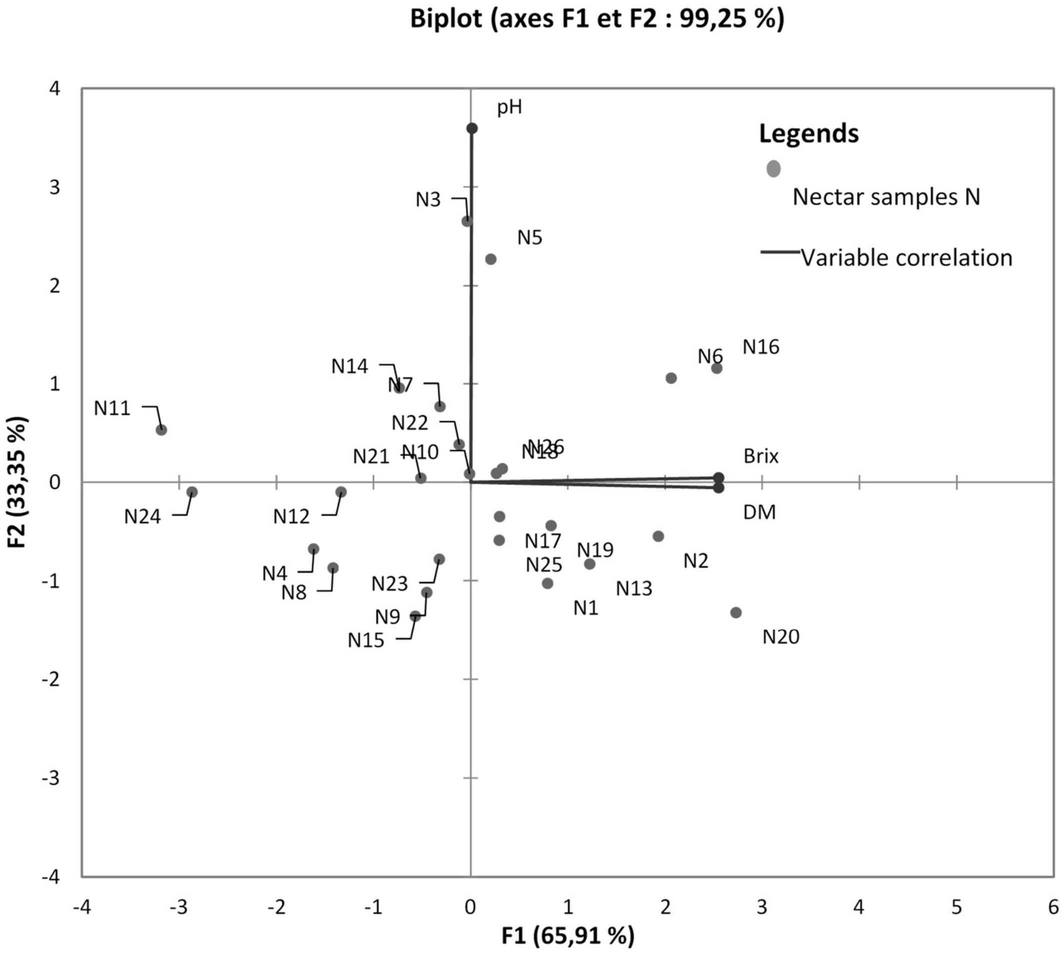

Figure 2: Correlations between the pH, Brix, dry matter and the nectars (N) produced in Benin

Color of Baobab pulp and derived liquid products

The baobab pulps color analysis revealed their significant difference (p≤ 5%), according to the hue, lightness and chroma (Table 3) which vary from 66.1 to 105.2 °, 82.4 to 90.2, and 29.0 to 37.0 respectively, for the 26 different brands.

The agglomerative hierarchical clustering revealed five homogeneous classes (Figure 3), with 18.1% (48.8) of intra-class variance, and 81.9% (220.6) of inter-class variance. Color of nectar clusters varied from red to yellow based on hue (Table 3). On average, 73.1% of the pasteurized nectars have an orange color, 7.7% have a red color, 19.2% an orange-yellow color. Based on the lightness, the first cluster (with an intra-class variance of 21.0) is inside the whitish zone. The second cluster (with an intra-class variance of 70.54) is at the border of the greyish and the whitish zones. The third, most heterogeneous cluster, (intra-class variance of 215.96), the fourth (intra-class variance of 25.87), and the fifth classes (intra-class variance of 43.54) are in the greyish zone (L=50).

Baobab syrups have a darkish dull-red color. Indeed, their color is in the reddish color area (Table 3). Their hue ranged from 24 ° to 38 ° (red to orange-red). Their low chroma (6.4 to 28.1) expresses the dull nature of color. And based on their lightness, syrups were ranged in dark grayish (lightness under 50).

Baobab products	Brands	Hue (in degree)	Chroma	Lightness	ΔE*	Sample's color (based on Hue)
Pulp (P)	P1	68.7±0.0[a,b]	36.3±0.6[c,d]	85.5±0.5[a,b]	33.9±0.4 [c,d,e]	Orange-yellow
	P2	74.9±1.5 [b,c]	35.0±0.3 [a,b,c,d]	90.2±0.3 [b,c]	29.7±0.4 [a,b,c,d]	Yellow
	P3	68.6±0.2[a,b]	35.9±0.2[b,c,d]	82.7±1.0 [a,]	34.4±0.2 [d,e]	Orange-yellow
	P4	66.1±0.6[a,]	37.0±0.5[d]	85.5±0.3[a,b]	34.6±0.3 [d,e]	Orange-yellow
	P5	67.8±0.1[a,]	34.8±0.2[a,b,c]	82.4±0.4[a,]	33.4±0.3 [b,c,d,e]	Orange-yellow
	P6	68.6±0.1[a,b]	36.2±0.2[c,d]	86.4±0.1[a,b,c]	33.5±0.2 [b,c,d,e]	Orange-yellow
	P7	105.2±1.4 [c]	29.0±0.4 [a]	95.0±0.2 [c]	25.0±0.4 [a]	Yellow
	P8	70.7±1.9[b,c]	30.8±0.4[a,b,c]	89.4±0.4[b,c]	27.6±0.5 [b]	Orange-yellow
	P9	74.2±4.7 [b, c]	31.6±0.9 [a,b,c]	89.7±0.6 [b,c]	28.3±1.1 [b,c]	Yellow
Nectar	Class 1 (n=5)	61.8±2.2[a]	32.4±10.3[a,b]	69.7±2.4[a]	38.1±3.3 [a,b]	Yellow-orange
	Class 2 (n=6)	55.4±4.6[b]	19.9±6.2[c]	64.0±3.3[b]	34.6±4.7 [a]	Orange
	Class 3 (n=2)	26.0±11.0[e]	14.2±8.8[c]	45.9±4.1[d]	35.1±20.3 [a,b]	Red
	Class 4 (n=7)	49.5±3.2[c]	34.0±3.0[a]	56.4±2.5[c]	49.1±1.7 [b,c]	Orange
	Class 5 (n=6)	41.0±4.8[d]	28.7±1.9[b]	45.9±4.1[d]	55.0±3.1 [c]	Orange
Syrup (S)	S_1	37.5±1.0[b]	28.1±0.4[a]	43.0±0.9[b]	57.3±1.1 [b]	Orange-red
	S_2	24.4±0.9[a,b]	21.1±0.3[b]	33.4±0.6[a,b]	63.8±0.5 [a]	Red
	S_3	24.4±1.2[a]	16.8±0.3[c]	33.1±0.9[a,b]	62.9±0.8 [a]	Red
	S_4	26.3±1.7[a]	6.4±0.7[d]	31.7±0.8[a]	62.6±0.8 [a]	Red

Table 3: Color of Baobab pulps, nectars and syrups.

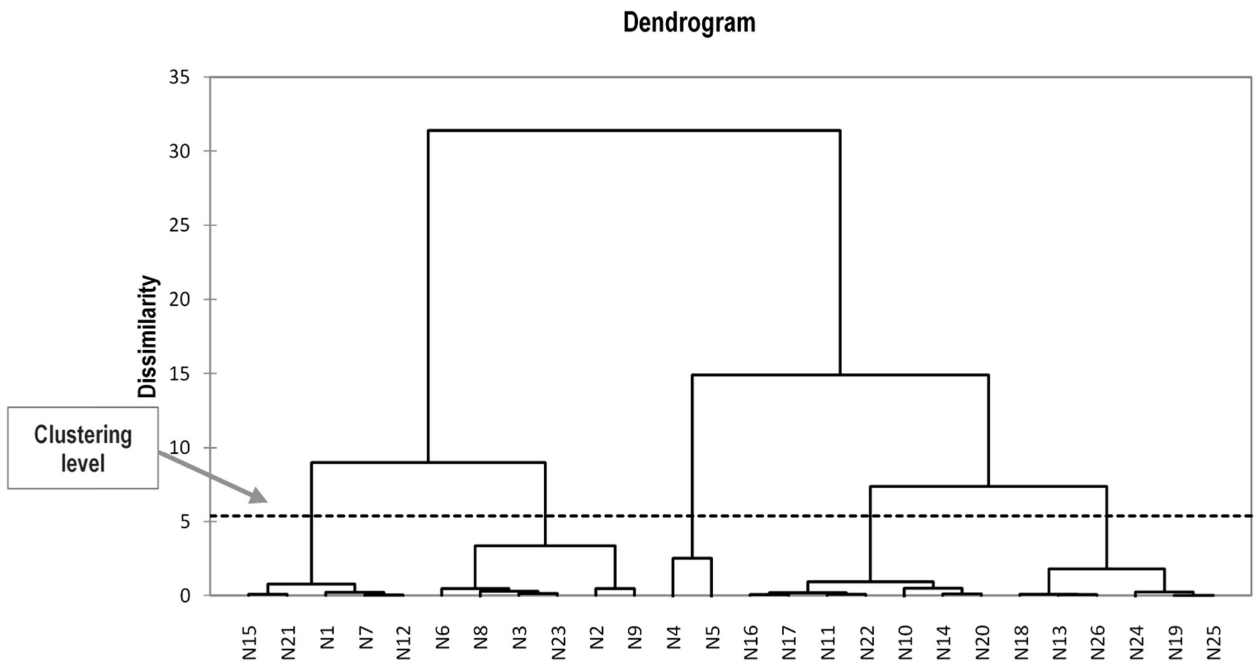

Figure 3: Dendrogram of agglomerative hierarchical clustering of baobab nectars color

Nn = Nectar produced by the processing unit "n"

DISCUSSION

Despite the fact that the baobab pulp pastils are produced by only one processing unit, they are the most encountered in Beninese markets, and represent the main baobab pulp derived product sold in pharmacies, suggesting a good distribution strategy of the concerned processing unit. Moreover, the presence of baobab pulp and pastils in pharmacies could certainly be linked to multiple functional and nutraceutical properties known for the baobab fruit pulp (Braca et al., 2018; Ibraheem et al., 2021; Tsetegho Sokeng et al., 2019; van der Merwe et al., 2019). The low number of the processing units involved in the manufacturing of selected baobab products namely the pastils, the cakes, the infant flour, the cocktails (baobab pulp – pineapple juice, baobab pulp – bissap extract), and the biscuits suggested that further researches must focus on them for better understanding. However, it may be due to the high processing cost and low accessibility to the used technology.

Among the physicochemical parameters, the pH is important to ensure safety and longer shelf life in foods products. Indeed, lower pH (< 4.5) are targeted by the Codex Stan 13-1981 for tomato (Codex Alimentarius, 2005) for the reduction of pathogenic microorganisms load. The low pH values of syrups, nectars and pulp suggested that the growth of pathogens is limited in these products. Furthermore, this low pH of baobab fruit pulp suggests its use as an acidifying agent. Traditionally, the baobab fruit pulp is used to produce Mutchayan, a traditionally fermented cereals (sorghum, millet or maize) dough, enhanced with baobab pulp nectar (Chadare et al., 2010), used as tonus provider. Moreover, the baobab pulp is very nutritive with vitamin C content ranging from 209 to 360 mg/100g (Chadare et al., 2009); its addition to foods increases their nutritional quality and mineral bio-availability (Makawi et al., 2019; van der Merwe et al., 2019).

Based on their dry matter contents (84-87.7 g/100g), about 77.8% of the baobab pulp processed in Benin is in inadequacy to European standards, specifying that the Baobab pulp dry matter must be higher than 88g/100g, according to the regulation (EC) N0 258/97 of the European Parliament (Vassiliou, 2008). Moreover, the presence of Enterobacteriaceae in pulp commercialized in Benin (8/9 processing units), even sometimes at low incidence, suggested a need for good manufacturing practices implementation along the Baobab pulp processing chain, by the different actors.

The low hues of baobab pulp may be linked to the variability of storage conditions, as applied by the local processors. The storage conditions affected significantly the baobab pulp color, which becomes darker (Chadare et al., 2008). The variation range between the pulp and the nectar or syrup, suggests that the variation of the processing technologies used has a significant effect on the browning of the packed pasteurized nectar or syrup. Indeed, during the pasteurization, the Maillard reaction which occurs due to the presence of proteins and reducing sugars leads to non-enzymatic browning (Hounhouigan et al., 2014). However, the Maillard reaction is important in the processing of some foods; it can contribute to increasing the antioxidant capacity of foods (Nooshkam et al., 2019). It is then important to study that reaction in pasteurized baobab pulp nectar and syrups for the improvement of their processing technologies, while considering consumer color preferences of baobab pulp derived products. This same variation range also suggested that bioactive compounds are also affected, as their variabilities were demonstrated to be correlated (r2 varying from 0.7 to 0.99) with the CIELAB color parameters (Sant'Anna et al., 2013).

The preservation of baobab pulp products quality overtime can be affected by the type of packages used; the package (in glass or plastic) used by local processors could limit the shelf life of the products through the change of its characteristics due to the acidity of baobab pulp products, particularly the liquids. During storage, interactions occurred between the food and its packaging; some particles can migrate from the plastic to the product; glass packages are better (Berlinet et al., 2008) as they reduce particle migration rate. According to Berlinet et al. (2008), the interactions between the food and its package are more important when the food is acid, hot and liquid. Many interactions may be considered in nectars and syrups, in comparison with dried baobab pulp products such as its pulp.

IMPLICATIONS FOR THE DEVELOPMENT

Different types of baobab pulp derived products are produced in Benin; mainly, they are the pulp, the nectar and the syrup. The quality, based on the dry matter and the Enterobacteriaceae count, revealed that the technics used for the processing and the storage of baobab pulp are not appropriated.

The installation of specialized units of storage and the adoption of good hygiene practices will contribute to the improvement of the pulp quality, and create added value to the baobab pulp, for the profit of all actors, from the farmer to the final consumer.

CONCLUSION

This research contributed in assessing the variation between baobab pulps, nectars and syrups available on the local market in Benin. These products were actually among the most commercialized and processed baobab derived products. The pulp microbiological characteristics revealed deficiencies in manufacturing practices during production. Significant differences in dry matter, pH and Brix values were observed in the sold nectars and syrups insinuating impact of processing technology or raw materials quality. The product's color was determined as varying from orange to yellow for pulps and from red to orange for syrups and nectars. Particular regards should be directed to the pulp microbiological quality by assessing its production process, and developing standardized processes for syrups and nectars production for variabilities mastering.

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