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Research Application Summary

Effects of processing technologies on the quality of pasteurized baobab nectars produced in southern Benin

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Abstract

In Benin, two main technologies are used to process baobab pulp into a pasteurized nectar, based on the number of the thermal treatments. As applied in processing units, the technologies do not affect significantly the quality of the pasteurized nectar in different ways. The derived products from the two technologies have the same dull orange color and vitamin C content, which are important for consumers. Further research should examine the pasteurization conditions effects on the nutritional, physico-chemical and microbiological quality by assessing the sporulated format.

Key words: Baobab, Benin, processing

Résumé

Au Bénin, deux technologies principales sont utilisées pour transformer la pulpe de baobab en un nectar pasteurisé, en fonction du nombre de traitements thermiques. Néanmoins, ces technologies appliquées dans les unités de transformation n'affectent pas de manière significative la qualité du nectar pasteurisé de différentes manières. Les produits dérivés des deux technologies ont la même couleur orange terne et la même teneur en vitamine C, importantes pour les consommateurs. Des recherches complémentaires devront examiner les effets des conditions de pasteurisation sur la qualité nutritionnelle, physico-chimique et microbiologique en évaluant le format sporulé.

Mots clés : Baobab, Bénin, transformation

Introduction

Adansonia digitata (baobab) is a multifunction tree whose leaves, seeds and pulp are edible, mostly consu y rura population in Africa (Assogbadjo *et al*, 2008; Assogbadjo *et al*., 2012). The nutrient-rich parts of Baobab plant, one of which is the pulp, have recently attracted the interest of the food factories and researchers due to the change in consumers needs which are more focused on products with the potential to promote health (Karelakis *et al*., 2019). Moreover, undernutrition and hunger are still the greatest challenges in the world (Baldermann *et al*., 2016).

The new interest on the baobab tree is related to its bioactive compounds. The Baobab pulp contains some bioactive compounds or nutraceutical substances whose consumption reduce the triglycerides and cholesterol in the living organisms (Alhassan *et al*., 2016; Xing-Nuo *et al*., 2017). Some of these molecules were identified in the pulp, by Tsetegho Sokeng *et al*. (2019): 28 carbohydrates, 6 organics acids with the citric acid as principal, 3 amino-acid in minor signals (alanine, y-aminobutyrate and threonine), different classes of flavonoids (tannins, flavan-3 -ols, flavonols, flavones) and other compounds as choline, ethanolamine, trigonelline, uridine and adenosine. Moreover, four hydroxycinnamic acid glycosides considered as anti-inflammatory, anticarcinogenic, and antimicrobial, have been reported in the fruit pulp. In order to help consumers to benefit from these nutraceuticals, the processing technologies applied in products using baobab pulp should be adapted for their conservation.

The Baobab pulp is generally processed in nectar, an homogeneous mixture of baobab pulp and water, sometimes with sugar and milk (Chadare *et al.,* 2008). This is commomly done in many west African countries including Benin (Chadare *et al.,* 2013), Ivory Coast (Ambe, 2001), Sudan (Adam, 2017), Senegal (Cisse *et al*., 2001), and Namibia (Lisao *et al*., 2017). The regular consumption of this nectar promotes health of its consumers by providing nutraceuticals. In Benin, the baobab nectar has been cited in many studies, but its quality and the technology used have been less investigated. The aim of this study was to identify the pasteurized baobab nectars technologies used in Benin and the effects on the quality of the derived baobab nectar.

Research approach

Identification of pasteurized baobab nectar processing technologies. The identification of the technologies was done through structured interviews with the heads of Baobab pulp nectar processing units or their collaborators, using a structured questionnaire. The processing units were selected using a database obtained after two exploratory field surveys in food outlets (in 2016 and in 2018), for the identification of baobab processing units. Two main municipalities, containing 51 baobab nectars processing units whit represent 66.67% of the pasteurized baobab nectar processing units in Benin, were chosen: Abomey-Calavi and Cotonou. The interview was carried out, on a voluntary basis, with 34 processing units. The collected data were mainly related to the pasteurized baobab pulp nectar technologies, and the quality criteriatof bab pulp.

For more details on processing technologies follow-ups were conducted twice in nine (9) processing units, selected on a voluntary basis. During thes9 follow-ups, various parameters were measured: the quantities of the raw material, water and sugar (using an electronic scale (Model KE 721)), and the temperatures of the thermal treatments, using a digital thermometer (CJ 101). The derived nectars were analyzed basing on the physico-chemical plan for consistency, dry matter, Brix degree, pH, titratable acidity and color.

Assessment of the effects of pasteurized baobab nectar technologies on its quality. To assess the effect of processing technologies on nectars produced in Southern Benin, pasteurized baobab nectar was produced using the two technologies shown in Figure 1, by simulating the processing unit conditions where pots were used for both types of thermal treatments and the fuel used was gas. For the technology with two thermal treatments, the first one was done at 91°C for eight minutes and the second was performed at 92°C for 14 minutes. For the technology of a single thermal treatment, this was done at 94°C for 11 minutes. The productions were repeated once samples of the pasteurized nectars from each production were subjected to physico-chemical and nutritional analyses for consistency, dry matter, Brix degree, pH, titratable acidity, color and vitamin C content.

Physico-chemical and nutritional analyses. The physico-chemical measurements performed were in terms of consistency, Brix degree, pH, titratable acidity, color and vitamin C content. The Brix value was determined using a digital refractometer VLVA, according to ISO 2173:2003 (ISO, 2003). Two (2) to three (3) drops of nectar were put on the refractometer. The value of the corresponding Brix was read directly. Likewise, the pH was determined in the well-homogeneous nectar, with a pH meter, EUTECH Instruments pH 510, according to the potentiometric method described in the standard ISO 41-5:1991 (ISO, 1991). The titratable acidity was determined according to ISO 750:1998 (ISO, 1998). Ten milliliters (10m1 of baobab nectar were mixed homogeneously with 90m1 of distilled water and the mixture was titrated with a sodium hydroxide solution (0.1N) until the pH 8.1±0.2 was reached. The titratable acidity was calculated and expressed in grams per liter of citric acid for 100 ml of the baobab nectar.

The consistency or flow velocity was measured with the Bostwick consistometer. It assessed the product's resistance to flow; the instrument measured the distance travelled by the nectar after 30 seconds, and this was expressed in cm/30s. On the other hand, the color of the nectars was determined using a CR410 chromameter (KONICA Minolta optics), and the color parameters expressed in the CIELAB color space (L*, a*, b* and AE) (Konica Minolta, 2003). Baobab nectars were poured into the small dishes (10 ml of volume) and the measurements were done in triplicate. The values L*, a*, b* and AE, indicate respectively the clarity (from 0 to 100 corresponding to black and white, respectively), the redness (from 0 to 60), the yellowness (from 0 to 60), and the total difference in color in comparison to the white reference color. The Hue H and the chroma (C) were calculated to determine the type and the tone of the color.

The vitamin C content, in its reduced form (ascorbic acid), was determined by titrimetric method following US ISO 6557-2:1984 (E) (UNBS, 2009), with 2.6-dichlorophenolindophenol (2.6-DCPIP) dyestuff. Samples were first filtrated, after which a portion of 5 ml was diluted with 5 ml of 2% (m/m), oxalic acid and titrate with the dyestuff solution until a salmon pink coloration persisted for at least five seconds, was obtained. The results were expressed as mg/100m1 dw of nectar.

Data analysis. All the data collected from the interviews, the processing follow-up and the assessment of the technologies' effects, were encoded in the software Excel 2013. The different technologies were identified by using the criterion with a potentially high effect on the baobab nectar quality, among the discriminatory unitary operations, on the basis of literature. The analysis of variance was done on the data collected during the assessment of the effect of technologies on the derived pasteurized nectar, using Minitab 18.

Results

Criteria choices for baobab pulp. In foods processing, the nature or the quality of the raw material determine the quality of the derived product. For their choice of a good baobab pulp, the local baobab processors consider: the granulometry of the pulp which is the most important criterion, followed by the acidity of the pulp and finally the color, the less considered criterion. Indeed, the fine granulometry contributes to the attractiveness of the pasteurized nectar, the less acid nectars are most accepted by consumers and the color indicates the freshness of the raw material, as revealed during the survey.

Criteria of pasteurized baobab nectar technologies. The results of the structured interview revealed several technologies differentiated by: the kind of the raw material used, the used ingredients, the number of filtrations, the number of thermal treatments, and the cooling nature (rapid using tap water and the type of primary package (glass bottles or plastic bottles used by 3% of the units).

In Benin, 88.24% of the selected processing units used baobab pulp and 11.76% used the pulp-wrapped seeds or the whole fruit as a raw material for nectar production. Around 70.59°A of the processing units added only sugar and 29.41% added other ingredients including natural flavoring agents (laurel or citronella or mint leaves) or synthetic flavoring agents (including vanilla, strawberry and synthetic mint), and acidifying agents (synthetic citric acid or lemon) to pulp and sugar. Regarding the nectar filtration, 58.8 % of surveyed units performed a single filtration, and 41.2 % practiced two filtrations; the first one comes before the first thermal treatment and the second right after. Most of the units (91.18%) practiced two thermal treatments while only 8.82% practiced a single thermal treatment; the first thermal treatment corresponded to the bulk pasteurization and the second to the in-pack pasteurization.

Pasteurized baobab nectar processing technologies. Based on the number of thermal treatments carried out on nectars, two technologies emerge: the technology with two thermal treatments and the one with a single thermal treatment (Fig.1).

The various unitary operations involved in the production of pasteurized baobab nectar were: the fruits' washing by removing physical wastes using brushes, the fruits' crushing using a hammer, the manual extraction of wrapped seeds, the soaking (45-90 minutes) of the wrapped seeds, followed by the mixing and the filtration-separation of the seeds from the mixture, the mixing of the added ingredients, the fi ltration, the first thermal treatment (85-96°C), the manual conditioning, mainly in recycled bottles, using bowls and funnel, the second thermal treatment (80-98°C) and the cooling practiced rapidly with tap water or slowly at room temperature. Where the raw material was pulp, already separated from the seeds, it was sieved and directly mixed with water and other ingredients.

The first thermal treatment, the bulk pasteurization, is done in stainless steel cookers, basins or pots, at 70°C-95°C, using gas as fuel. The second thermal treatment, the in-pack pasteurization, is practiced also in pots and basins; the sealed bottles are put in the cooker, and the bottles are added until all the bottles are covered.

The ratio of the different ingredients added varies in function depending on the nature of the raw materials. In the case of the extracted pulp, 1 kg of the pulp and 0.3 kg of sugar are added to 7.75 L of water. In the case of th pulp-wrapped seeds, lkg of the wrapped seeds and 0.3 kg are mixed to 4.5 L of water.

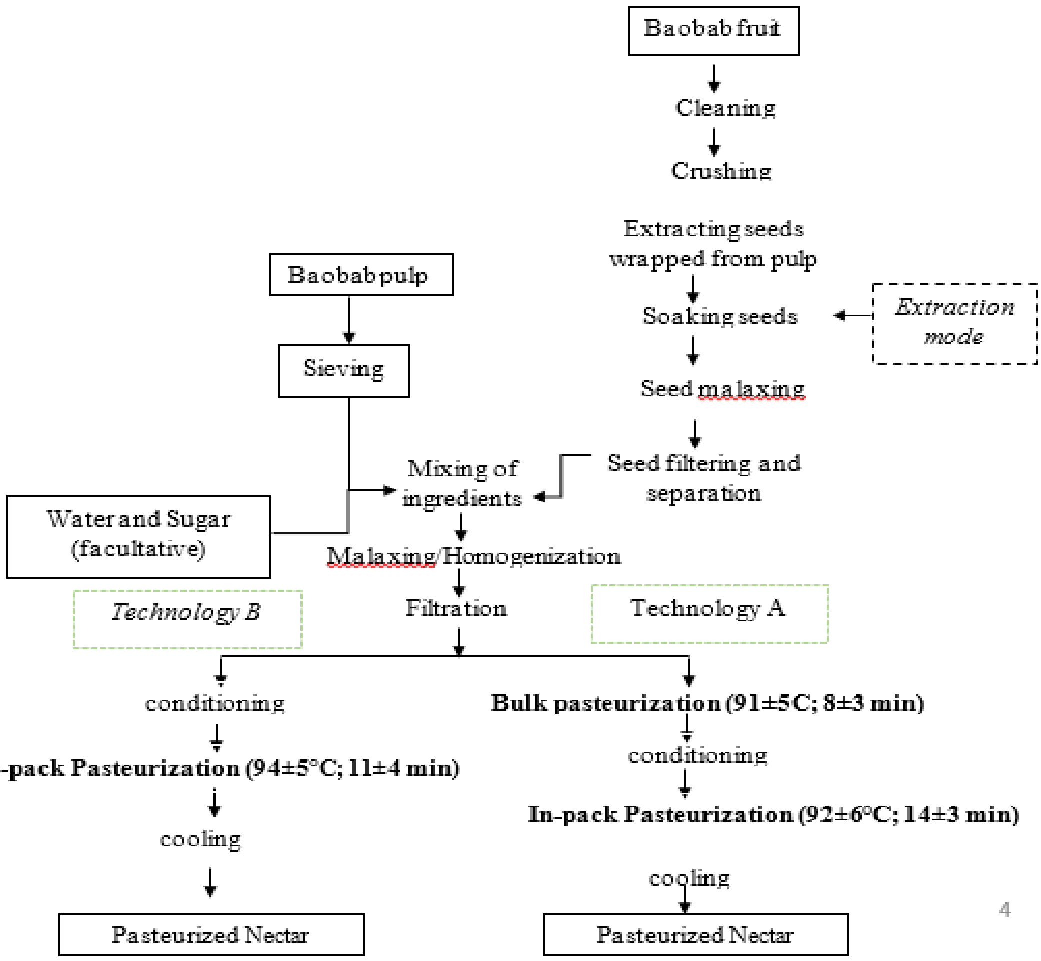

Fig. 1. Pasteurized baobab nectar production chart practiced in Benin

Variability of the pasteurized baobab nectars produced by the processing units. The quality of the pasteurized baobab nectar is variable from one production to another one. Indeed, 55.6% 2Ltil,e nectars produced by the processing units varied from one production to one another (Table 1). It also varied from one processor to another, in terms of the flow velocity, the yellowness, the total color difference of the sample when compared to he white reference, the redness, the titratable acidity, the brix value, the lightness, and the pH: 2.7-86.5%, 3.5-31.3%, 0.0-24.3%, 0.1-23.2%, 0.0-22.2%. 0.6-11.0%, 0.0-6.5%, and 0.0-2.1%, respectively.

Effects of thermal treatments on quality of nectar produced in Benin. The type of technology affects significantly the quality of the derived nectar (Table 2). Indeed, the technology applied affects not only the Brix value but also the vitamin C content, but the color was not affected by the type of technology used. As the number of the thermal treatments increased, a non-significant increase was observed for the hue, dry matter, and a contrastingly non-significant decrease in the lightness and the vitamin C content.

Table 1. Characteristics of pasteurized baobab nectars produced in southern Benin

Processors	Flow velocity (cm/30s)	Brix	L*	a*	b*	ΔE	pH	ATT	
P1	Mean	66.65	17.63	75.96	5.13	7.35	18.66	3.25	12.97
(TA)	CV	75.54	7.23	3.28	7.22	6.74	11.17	1.12	8.13
P2	Mean	22.13	17.15	74.17	4.93	5.81	20.08	3.25	12.67
(TB)	CV	5.65	0.58	0.68	5.40	7.83	2.65	0.04	0.04
P3	Mean	15.34	19.14	70.95	8.61	12.32	26.04	3.18	14.13
(TB)	CV	2.72	5.54	6.49	23.18	31.26	24.29	2.08	3.98
P4	Mean	1798.75	9.55	63.24	11.88	18.29	36.38	3.27	7.17
(TA)	CV	12.22	5.24	0.20	10.23	5.76	2.64	1.23	0.04
P5	Mean	112.89	15.74	73.99	6.03	7.56	20.83	3.22	14.28
(TA)	CV	86.47	11.04	0.30	17.76	8.50	2.51	0.31	22.19
P6	Mean	543.25	13.65	73.29	4.98	5.86	20.92	3.14	8.83
(TA)	CV	23.19	3.48	0.00	0.13	3.50	0.01	0.08	1.69
P7	Mean	127.75	13.38	73.78	4.98	6.41	20.55	3.18	12.23
(TA)	CV	25.64	2.80	0.37	0.10	8.74	1.08	0.08	0.60
P8	Mean	959.25	13.93	72.74	6.20	5.02	21.93	3.14	10.42
(TA)	CV	8.44	0.72	0.08	3.97	7.33	2.01	0.08	0.72
P9	Mean	1502.38	11.44	72.11	4.68	5.00	21.91	3.15	7.88
(TB)	CV	5.48	6.67	0.39	1.55	3.98	0.83	0.32	4.19

The values in bold character indicate that the considered parameter vary for the same processor.
CV Coefficient of variation. TA Technology A. TB Technology B.

Table 2. Variation in pasteurized baobab nectar quality under two technologies

Sample	Brix	pH	Titratable acidity (g/L dw)	Dry Matter (g/100g)	L*	Vit C (mg/100g dw)
Nectar TA	12.92±0.2a	2.69±0.1a	717.01±21.2a	13.18±0.3a	73.38±0.3a	180.05±7.0a
Nectar TB	12.17±0.0b	2.60±0.0a	735.0±22.9a	12.67±0.0a	74.28±0.1a	209.84±8.7a
Baobab pulp	-	-	-	-	-	299.13±9.0

The values with different letters in the same column are significantly different. TA = Technology A; TB = Technology B

The color analysis of the pasteurized nectars revealed that both technologies produced nectars of the same color (dull orange), based on the chroma and the hue values (Fig. 2).

Appropriateness of the pasteurized baobab nectar technologies as applied by local processing units. The pasteurized baobab nectar technology with a single pasteurization showed several advantages, when compared to the technology with two pasteurizations. Indeed, the use of single pastevlization reduced the processing duration and the consumed energy during the production. However, few processors use of single thermal treatment (the in-pack pasteurization).

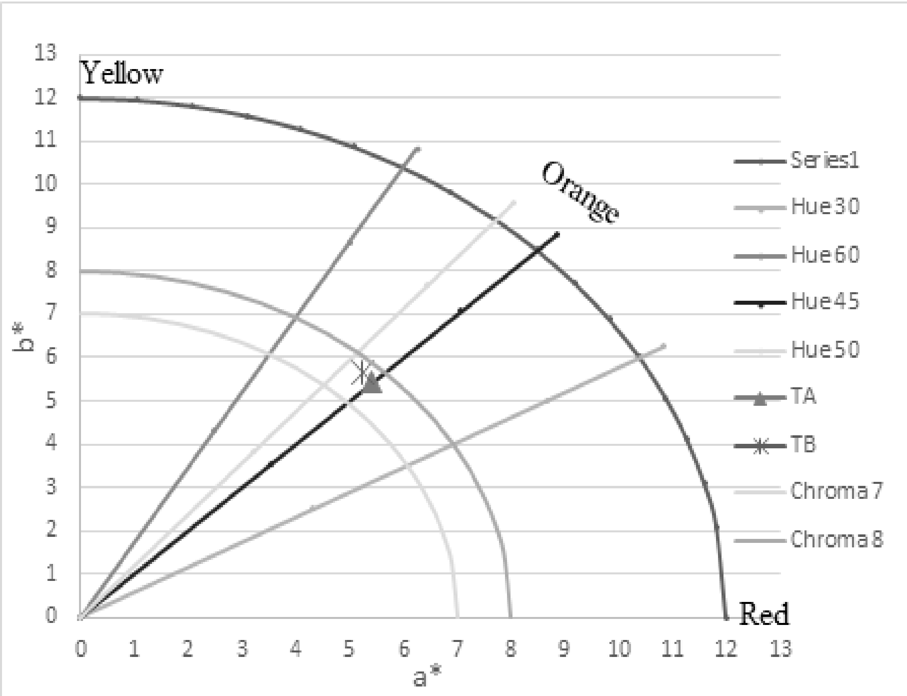

Figure 2. Color of pasteurized baobab nectars

Adaptability of the applied pasteurization scales to a viscous pasteurized baobab nectar produced in Benin. In relation to the pasteurization scales, the ones applied in local Beninese processing units seems too severe. Some authors recommend to pasteurize baobab nectar (100g of pulp diluted in 1L of water) at 72°C for 15 seconds (Tembo *et al*., 2017) for better conservation of vitamin C. According to Cisse *et al*. (2009) this kind of pasteurization scheme, when applied at 70°C for 10 minutes, does not contribute to preserve the sensorial quality of the nectar when the latter is stored for 1 l da-ys at 4°C. The same author indicated that the quality variability was about 10% when the nectar was treated at 80°C for 10 minutes or 90°C for 5 minutes, and stored for 8 days at 37°C. It may be concluded that the pasteurization of baobab nectar at 72°C for 15 seconds can only be done in conditions where the derived product has to be consumed immediately. The variation observed by Cisse *et al*. (2009) in the stored pasteurized baobab nectar quality could probably be explained by the thermo-resistant germs of spores which can change the sensorial quality without affecting the safety of the products; one of these sporulated germs reported in beverages industries is Alicyclobacillus acidoterrestris (Silva and Gibbs, 2001; Kumar *et al*., 2013).

Based on the above aspects, for the purpose of a long duration conservation, the pasteurization scales (9415°C for 11 minutes), as applied by Beninese processing units, could be adapted even if they contribute to lowering of vitamin C content.

Conclusion

In Benin, two main technologies are used to process baobab pulp into a pasteurized nectar, based on the number of the thermal treatments. As applied in processing units, the technologies do not affect significantly the quality of the pasteurized nectar in different ways. The derived products from the two technologies have the same dull orange color and vitamin C content, which are important for consumers. Further research should examine the pasteurization conditions effects on the nutritional, physico-chemical and microbiological quality by assessing the sporulated format.

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