Effect of Babassu (*Orbignya phalerata*) Mesocarp Flour on the Sensorial Properties and Nutritional Value of Cookies

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Abstract The use of the babassu mesocarp flour (BMF) in the cookies production adds value to this regional raw material of Brazilian Northeast. BMF has high mineral and fibers content and can increase the nutritional value of the products. However, it's essential to evaluate the sensory impact. Thus, the study aimed to produce cookies containing BMF in partial replacement of wheat flour. For this, four cookies formulations were prepared: control (0%), 25%, 50% and 75% of BMF. The sensory attributes (color, appearance, flavor, texture and overall liking) and purchase intention were performed. All samples containing BMF were accepted with averages greater than 6, which corresponds to "slightly liked" in the hedonic scale. For the flavor, cookies with 50% de BMF had high scores ($p < 0.05$) when compared to that with 75% of BMF. The cookies containing 50% of BMF was more accepted ($p < 0.05$) for the overall liking than those of control and with 75% of BMF. Thus, the formulation with 50% of BMF highlighted for the majority of sensory attributes. This formulation was produced and compared with control treatment for the proximate composition (moisture, ash, lipids, proteins, fiber, carbohydrates and energy value). The use of BMF did not influence the moisture of the cookies. However, it caused a reduction ($p < 0.05$) in the proteins and carbohydrates. The lipids, minerals, fibers contents and consequently energetic value increased ($p < 0.05$) with BMF inclusion. The increase in fiber content is advantageous since their consumption provide several health benefits. Therefore, the cookies prepared were accepted and promote the use of regional raw material of Brazilian Northeast with high nutritional value.

Keywords: Babassu mesocarp flour, cookie, sensory evaluation, nutritional value

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1. Introduction

Brazil is very rich in natural resources, generates an amount of agro-industrial waste. The babassu coconut (*Orbignya* sp.) is one of the most abundant palm trees on the north and northeast Brazil which has four different parts, the outermost fiber-rich epicarp, the starch-rich mesocarp, the hard and woody endocarp and the innermost oil-rich kernels. Babassu palm trees can reach 20 m in height, with the production of four bunches of fruits per palm per season. The trees produce between seven and ten years and end at 35, with a productivity of 2.2 to 15.6 tons of fruit per ha/year. The Brazil has estimated potential of 6.8 million tons of fruits/year and Maranhão is the state with the highest potential (92%) [1,2].

The babassu mesocarp, a byproduct of the babassu oil extraction industry, is produced during the separation of

the babassu coconut almonds and consists of 20–23% of the fruit weight. Babassu mesocarp is an edible starch source (60–90%), and it displays antioxidant properties because it contains phenolic compounds [3,4]. Thus, its use in foods production like biscuits would be a promising alternative.

However, according to Maniglia and Tapia-Blácido [5], despite being rich in starch, babassu mesocarp has only been explored as animal food and biomass. Thus, there are few reports in the literature evaluating the potential of mesocarp flour in food production.

Cavalcante Neto et al. [6] evaluated the babassu mesocarp flour (BMF) as a partial substitute of wheat flour in fresh pasta. These authors reported that BMF provided high protein and fiber content when compared to the traditional one, improving nutritional value. Couri and Giada [7], also observed the nutritional value of bread provided with 5% and 10% of BMF. These authors found that there was an increase in fibers and decrease of

carbohydrates. Moreover, the bread with BMF was well accepted sensory by the panelists.

Cookies are very popular and easy-to-eat products that consumed all over the world. As such, they could be great carriers of nutritionally valuable compounds. Unfortunately, such products in the market very often contain fat rich in saturated and *trans* fatty acids. However, products with wholegrain flour are becoming more popular due to the consumers' increasing awareness of a healthy lifestyle. Scientific papers report the possibilities of using bioactive compounds such as dietary fibers [8,9] and vegetable flours [10] to make these foods healthier. According to Onacik-Gur et al. [11], the addition of such ingredients may very often have an adverse impact on texture properties and sensory characteristics of cookies. Fibers and components with high protein content may increase the hardness of bakery products. Fruit pomaces and plant extracts changed the color. Therefore, it is essential to evaluate the sensory acceptance of products added to the different ingredients.

The BMF has a high concentration of some components such as fibers (17.9%) and ash (3.4%) when compared to wheat flour (2.3% of fibers and 0.8% of ash) [12]. Thus, the cookies production with BMF can provides the product with higher amount of fibers and minerals.

Therefore, this study aimed to produce and evaluate cookies containing BMF in partial replacement of wheat flour.

2. Material and Methods

2.1. Processing of Cookies Containing the Babassu Mesocarp Flour (BMF)

This study was divided into two stages. First, four formulations of cookies were produced (Table 1): control (without BMF addition), and containing 25%, 50% and 75% BMF in substitution of the wheat flour. The sensory acceptance of these formulations was evaluated to choose the most accepted. For the first stage, the experimental design was four formulations and 100 panelists. After, the proximate composition of the most accepted formulation was determined and compared with control. The experimental design of this stage, it was (2x5), 2 treatments (control and 50% of BMF) and 5 replicates.

Table 1. Cookies formulations made with babassu mesocarp flour (BMF)

Ingredients (%)	0%	25%	50%	75%
Wheat flour	100	75	50	25
BMF	-	25	50	75
Crystal sugar	14	14	14	14
Brown sugar	59	59	59	59
Sodium bicarbonate	1	1	1	1
Eggs	35	35	35	35
Hydrogenated vegetable fat	59	59	59	59
Vanilla (%)	2	2	2	2

For the cookies production, hydrogenated vegetable fat and eggs were mixed for approximately 5 minutes with a planetary electric mixer (BPAI, ARNO, Brazil), until the emulsion was fully homogenized. Crystal and brown

sugars were then added and the whole dough was mixed for another 5 minutes. The remaining dry ingredients were mixed and kneaded until the consistency of dough became uniform. The dough was subsequently flattened with a rolling pin down to a 6 mm sheet and cut into 5 mm diameter circular shapes. The baking was conducted in an domestic oven at 19°C for 30 minutes.

2.2. Sensory Acceptance of Cookies

This study was submitted and approved by the Research Ethics Committee of the Federal University of Maranhão (CAAE: 70909317.5.0000.5087). All the panelists signed the Informed Consent Term, following the norms of the National Council of Ethics in Research with Humans. Sensory evaluation was performed by 100 untrained panelists, who were selected by like and consumed cookies. Samples (25 g) were served individually in a monadic sequential order using a balanced block design.

The attributes evaluated were color, appearance, texture, flavor, and overall liking. The hedonic scale was used, ranging from 1 (dislike extremely) to 9 (like extremely). The purchase intention was also evaluated by use of a 5-point scale, ranging from 1 (I certainly would not buy) to 5 (I would certainly buy) [13].

2.3. The Proximate Composition of Cookies

For moisture determination, the infrared drying equipment (ID-50, MARCONI, Piracicaba, Brazil) was used. For this, approximately 5 g of samples were weighed. The moisture percentage were obtained directly from the equipment. Protein, ash, lipid and fibers contents were determined according to the methodology described by the Association of Official Analytical Chemists [14].

For proteins, quantities of approximately 0.5 g of cookies samples were transferred to a digester tube. Then 15 mL of sulfuric acid and 10 g of a catalytic mixture (anhydrous sodium sulfate and anhydrous copper sulfate) were added. The tubes were heated in the digester to 350°C, in an exhaust chamber, until the solution turned greenish-blue and free of undigested material (black points), after which they were maintained at that temperature for another hour and then allowed to cool. The tubes containing the digested samples were then transferred to an automatic Kjeldahl distillation system. The distillate, with light blue colour, was titrated with a solution of sulfuric acid 0.05 M that had been previously standardized. The protein content was calculated using factor of 5.7.

For the ash content, samples weighing approximately 5 g of cookies samples were placed in previously weighed porcelain crucibles. The samples were then carbonized over a Bunsen burner and placed in a muffle furnace where they were heated to 550°C, left at this temperature for 12 h and then transferred to a desiccator containing silica gel. After reaching room temperature (25°C), the crucibles containing the samples were weighed to determine the ash content by difference.

For the lipid content, quantities of approximately 5 g of each cookie sample were previously weighed and heated to 105°C. After, they were transferred to a Soxhlet extractor, coupled to a round-bottom flask. The volume of

the extractor chamber was completed by adding about 150 mL of n-hexane. A condenser was adapted to the upper part of the extractor and the flask was kept heated for 8 h. The lipid content was calculated by the difference between round-bottom flask with lipids and the empty round-bottom flask.

Total carbohydrates were calculated by difference (100 - moisture, protein, lipids, and ashes). The total level of carbohydrates contained in the samples corresponds to the sum of the amylaceous carbohydrates and non-digestible carbohydrates (fibers). The analysis fiber was performed by subjecting the samples to acid digestion with 1.25% sulfuric acid followed by digestion alkaline with 1.25% sodium hydroxide. The caloric value was obtained by using the Atwater factors [15].

2.4. Statistical Analysis

All statistical analyses were performed using XLSTAT software (Addinsoft, Paris, France). The sensory data, treatments were considered as a fixed source of variation and the consumer as a random effect. The attributes were analyzed by the non-parametric Friedman test at the 95% confidence level ($p < 0.05$). The proximate composition parameters were analyzed by one-way ANOVA with Paired t-test at the 95% confidence level ($p < 0.05$).

3. Results and Discussion

3.1. Sensory Acceptance of Cookies

In all treatments, the sensory attributes were positively scored in the hedonic scale, with a rating between “like slightly” and “like extremely” (6–9) (Table 2). Therefore, all formulations are good market alternatives. This good acceptance is a satisfactory result because 90% of the panelists said that never consumed products containing BMF.

For the color and appearance, the acceptance of the cookies with 50% de BMF was high ($p < 0.05$) when compared with control. The cookies with 25% and 75% BMF did not differ from the other treatments (Table 2). The similarity of appearance and color, indicate that the color is the main parameter evaluate into the appearance.

Table 2. Mean values and standard deviation of the sensory attributes color, appearance, texture, flavor and overall liking of cookies containing babassu mesocarp flour.

Attributes	Babassu mesocarp flour (%)			
	0	25	50	75
Color	7.00 ± 1.70 ^b	7.78 ± 1.21 ^{ab}	7.98 ± 1.11 ^a	7.73 ± 1.49 ^{ab}
Appearance	7.22 ± 1.26 ^b	7.77 ± 1.00 ^{ab}	8.02 ± 0.87 ^a	7.72 ± 1.19 ^{ab}
Texture	6.65 ± 1.85 ^b	7.32 ± 1.48 ^b	8.00 ± 1.09 ^a	7.27 ± 1.53 ^b
Flavor	6.83 ± 1.81 ^{ab}	7.60 ± 1.32 ^{ab}	7.52 ± 1.40 ^a	6.83 ± 1.72 ^b
Overall liking	6.83 ± 1.60 ^c	7.70 ± 1.05 ^{ab}	7.78 ± 1.12 ^a	7.02 ± 1.69 ^{bc}

Means with different letters in the formulation's columns differ according to the Friedman test ($p < 0.05$).

Demirkesen [9] reported that substitution of rice flour with chestnut flour improved color scores of cookies when prepared with until 40% replacement level. Above this

ratio, the cookies color was darkened by the progressive increases in substitution levels. Therefore, acceptance scores declined. This author concluded that the natural color of chestnut flour provided the alterations in the color of the cookies. Herein, also there was great darkness of cookies provided by the natural color of BMF which consists of a brownish color resulting from the presence of tannins. But, the BMF had a positive effect in the color because improved acceptance until 50% and did not have modifications in the acceptance with higher concentrations.

Sudha et al. [16] reported that the use of oat, wheat and barley bran in substitution to the wheat flour in biscuits provided increased of the darkness and reduction of sensory scores. At according to these authors, at 10% incorporation of bran did not affect the quality of biscuits, but this quality was acceptable at 20% for wheat bran and barley bran and 30% for oat bran only. Thus, the results obtained herein was satisfactory because 50% of BMF improved acceptance.

The texture acceptance of the cookies with 50% de BMF was high ($p < 0.05$) (Table 2). Paragados [17], evaluating the texture acceptance of cookies containing canistel in replacement to wheat flour, also observed that the concentration of 50% was the better. According to this author, the high texture acceptance is due to the tenderness and crispiness of the canistel flour that is better accepted with 50%. Therefore, this author concluded that crispiness is affected by blend proportions.

Crispiness is essential in determining the consumer acceptability of cookies [18]. Thus, in the present study, also was reported by panelists that the blend of 50% BMF with 50% of wheat flour provided the better crispiness. Concentrations of BMF below 50% were very crispy and above with little crispiness.

For the flavor, cookies with 50% de BMF had high scores ($p < 0.05$) when compared to that with 75% of BMF (Table 2). Chauhan et al. [19] reported a increase in flavor acceptance with up to 60% of amaranth flour in cookies. The sensory score for flavor decreased with addition above 60% amaranth flour. These authors said that this result might be due to the bitter aftertaste of amaranth flour. In the present study, the lower flavor acceptance of cookies with 75% also may be bitter aftertaste, that was reported by consumers.

The cookies containing 50% of BMF was more accepted ($p < 0.05$) for the overall liking than those of control and with 75% of BMF (Table 2). Results different those obtained herein were reported by Giubert et al. [20] These authors observed a reduction of cookies acceptance in all inclusion level of alfalfa seed flour (15, 30 and 45%). According to these authors, the higher presence of phenolic compounds would elicit a bitter taste, thus causing possible adverse effects on individual preference decisions. In the present study, the BMF also is a source of phenolics compounds in composition [5]. However, until 50% of inclusion, the acceptance was better than the control treatment.

The purchase intent evidenced the good acceptance of the samples containing 25 and 50% of BMF that had more than 70% of the interest in the “I would buy.” The cookies containing 75% BMF confirmed the results of scale hedonic, having higher percentages in the “I would not buy” (Figure 1).

Figure 1. Purchase intent of cookies containing babassu mesocarp flour

In most of the evaluated attributes, the formulation with 50% BMF was more accepted. Thus, this formulation was selected to be analyzed its proximate composition and compared with the control treatment.

3.2. Proximate Composition of Cookies

There was no difference ($p>0.05$) for the moisture, indicating that this flour did not influence this parameter (Table 3). Different results were reported by Couri and Giada⁷ that observed an increase of moisture with the BMF flour addition in bread. According to the authors, the National Surveillance Agency Sanitary recommends for bakery products the limit value of 38% moisture. Thus, the results of the present study are within the established limits.

Table 3. Proximate composition of cookies containing the babassu mesocarp flour

Properties	100 WF ¹ + 0 BMF ²	50WF + 50BMF
Moisture (%)	2.14 ± 0.44 ^a	2.34 ± 0.60 ^a
Ash (%)	1.09 ± 0.01 ^b	1.19 ± 0.03 ^a
Lipids (%)	18.64 ± 1.04 ^b	24.62 ± 0.78 ^a
Proteins (%)	3.55 ± 0.60 ^a	2.30 ± 0.87 ^b
Fiber (%)	3.64 ± 0.16 ^b	4.69 ± 0.25 ^a
Carbohydrates (%)	69.99 ± 2.73 ^a	64.01 ± 2.29 ^b
Energy value (Kcal)	468.32 ± 11.23 ^b	496.48 ± 17.50 ^a

Means with different letters in the formulation's columns differ according to the t-test ($p<0.05$).

¹WF = wheat flour

²BMF = babassu mesocarp flour.

The ash content was high ($p<0.05$) when BMF was added (Table 3). This increase was expected because the BMF has high ash content (3.4%) when compared to wheat flour (0.8%). BMF is a good source of minerals, such as Ca, Mg, K, and Fe. Therefore, due to this characteristic, the BMF addition in the foods may be a viable alternative to healthy eating [12].

For the lipids, the cookies with BMF had high values ($p<0.05$) (Table 3). Cavalcante Neto et al. [6] also observed the increase of lipids with BMF addition in pasta. These authors highlighted that the lipid content is relevant from a technological point of view since the fats have great importance concerning the softness of the product. Therefore, the inclusion of FMB in the cookies increase the lipid content.

The protein content of the samples with 50% BMF was lower than control (Table 3). This lower value is due the BMF has smaller (1.2%) when compared to wheat flour (9.8%) [12]. Mounjouenpou et al. [21] and Hussain et al. [22] also observed a decrease in protein content in cookies enriched with baobab pulp flour and buckwheat flour, respectively. Thus, the reduction in the proteins values of cookies is resultant of protein content of BMF.

For the fiber content, it was observed an increase ($p<0.05$) with BMF addition (Table 3). Kaur et al. [23] also found an increase in the fiber content with raw and roasted flaxseed flour in cookies. The high values of fiber reported by these authors were 2.37%, that concluded that the addition of natural and roasted flaxseed flour with lignin-rich dietary fiber in cookies improved the nutraceutical properties and developed nutritious health product. In the present study, it was obtained values of 4.69% with the use of BMF. Thus, we can affirm that the BMF improved the nutritional characteristics of the cookies.

For the carbohydrates, the sample with 50% BMF presented lower ($p<0.05$) results (Table 3). Similarly, Mounjouenpou et al. [21] also observed a reduction in the content of this nutrient by replacing wheat flour with baobab flour.

The BMF addition provided an increase of 6% in the energetic value of the cookies when compared to those of control formulation. The increase in the energy value was also reported by Kaur et al. [23] when formulating added flaxseed cookies. Despite the small increase (6%) obtained in energy, FMB provided an increase in the fiber content (28.9%) in cookies. According to Bernaud and Rodrigues

[24], dietary fiber intake is associated with a reduction in blood glucose, blood pressure, and serum lipids, as well as the reduction of chronic diseases such as cardiovascular diseases and diabetes.

4. Conclusion

Cookies with babassu mesocarp flour had good sensory acceptance, and the formulation with 50% of BMF highlighted for the majority of sensory attributes. Moreover, this formulation had higher mineral and fibers content when compared to the treatment with wheat flour.

Thus, the development of cookies produced with babassu mesocarp flour reduce food waste by adding value to a by-product with good nutritional qualities.

Conflicts of Interest

All authors declare no competing interests.

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