

**Elaboração de biscoitos com extrato em pó proveniente da torta residual de amêndoas
de coco babaçu: caracterização físico-química e sensorial**

**Sensory and physical-chemical evaluation of cookies made with extract powders of
babassu coconut pie**

**Elaboración de galletas hechas con extracto en polvo de la torta de almendras de coco
babassu residual: caracterización físico-química y sensorial**

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Resumo

A demanda por produtos elaborados a partir do aproveitamento de resíduos alimentares vem crescendo nos últimos anos. Neste sentido, esse estudo objetivou desenvolver e avaliar biscoitos elaborados com extrato em pó proveniente da torta residual de amêndoas de babaçu. Foram elaboradas três formulações de biscoitos com diferentes concentrações de extrato em pó (F1-5%, F2-15%, F3- 25%). Verificou-se que o conteúdo de proteínas dos biscoitos variou entre 2,75%- 2,99% e o de lipídeos entre 26,12%-26,89%, além disso, encontram-se dentro dos padrões microbiológicos estabelecidos pela legislação. Entre as formulações testadas sensorialmente, a F3 foi caracterizada, como a mais doce pelo painel treinado. Por outro lado, o teste afetivo apontou a formulação F2 como sendo a mais aceita pelos provadores, com índice de aceitação de 80,86%. Portanto a elaboração de biscoitos a partir do extrato em pó proveniente da torta residual de amêndoas de coco babaçu consiste em uma alternativa de agregação de valor a este coproduto com potencial de comercialização.

Palavras-chave: Secagem por spray dryer; Biscoitos; Análise descritiva quantitativa.

Abstract

The demand for products made from food waste has been growing in recent years. In this sense, this study aimed to develop and evaluate cookies made with powdered extract from the residual babassu almond cake. Three biscuit formulations were prepared with different concentrations of powdered extract (F1-5%, F2-15%, F3-25%). It was found that the protein content of cookies varied between 2.75% - 2.99% and that of lipids between 26.12% -26.89%, in addition, they are within the microbiological standards established by the legislation. Among the sensorially tested formulations, F3 was characterized as the sweetest by the trained panel. On the other hand, the affective test pointed out the formulation F2 as being the most accepted by the tasters, with an acceptance rate of 80.86%. Therefore, the preparation of biscuits from a powdered extract from the residual babassu coconut almonds pie is an alternative to add value to this co-product with commercial potential.

Keywords: Spray drying; Cookies; Quantitative descriptive analysis.

Resumen

La demanda de productos elaborados a partir de residuos de alimentos ha ido creciendo en los últimos años. En este sentido, este estudio tenía como objetivo desarrollar y evaluar las galletas hechas con extracto en polvo de la torta de almendras babassu residual. Se prepararon tres formulaciones de galletas con diferentes concentraciones de extracto en polvo (F1-5%, F2-15%, F3- 25%). Se comprobó que el contenido de proteínas de las galletas variaba entre el 2,75% y el 2,99% y el de lípidos entre el 26,12% y el 26,89%, además, están dentro de las normas microbiológicas establecidas por la legislación. Entre las formulaciones probadas sensorialmente, el F3 fue caracterizado como el más dulce por el panel entrenado. Por otra parte, la prueba afectiva indicó que la formulación F2 era la más aceptada por los catadores, con una tasa de aceptación del 80,86%. Por lo tanto, la preparación de galletas a partir del extracto en polvo de la torta residual de almendras de coco babassu constituye una alternativa para añadir valor a este coproducto con potencial de comercialización.

Palabras clave: Secado por aspersión; Galletas; Análisis descriptivo cuantitativo.

1. Introduction

The agroindustry generates tons of residues that can cause environmental problems. However, these by-products may have health beneficial effects often due to improvement in nutritional composition. Therefore, alternatives for agro-industrial by-products reuse have been growing in recent years such as obtaining powders for incorporation into food products, increasing their nutritional and economic potential (Garcia, Milani & Ries, 2019).

Brazil is known for being a country with a great diversity of ecosystems, highlighting a considerable number of palm species, including babassu. The coconuts of this palm are used for industrial production of oil and water-extract (babassu coconut milk) (Parente et al, 2019). The process of babassu oil generates solid residues, known as pie. Usually, this residue is used to production of animal food (Sá, Teles, Borges, Junior, Silva, 2014). However, it presents favorable nutritional characteristics, which allow its use in humans food. Sá et al. (2014) found 25.47% of proteins and 7.85% of lipids in babassu pie. Therefore, this residue has the potential to be used as a nutritional ingredient in food products.

Recent studies analysed the incorporation of the agro-industrial by-products powders in new food products: Brazil nut pie in protein rich products (Souza, Ferreira, Correa & Santos, 2016), orange residue in ice creams (Oliveira, Winkelmann & Tobal, 2019), passion fruit peel in dietetic cookies (Garcia, Milani & Ries, 2020), among other. These studies confirm the

potential of the agro-industrial by-products for food industry applications.

However, there are no studies and commercial products containing babassu pie powders in food products yet, although it would be very interesting to study their possible industrial utilization. Thus, this research aimed to develop and evaluate, through physical-chemical, microbiological, and sensory tests, three cookie formulations made with the powdered extract obtained from the residual babassu coconut almond pie.

2. Material and Methods

This study is a laboratory research with quantitative nature and control of all environment conditions accord to Pereira, Shitsuka, Parreira and Shitsuka (2018). The authors included in these classification drying by spray dryer, cookies formulation and characterization, and physical-chemical, microbiological and sensory analysis.

The research was developed at Laboratory of Biomolecules Separation and Food Dehydration, Universidade Federal the Tocantins - LAPSDEA/UFT. Babassu (*Orbignya phalerata* Mart.) almonds were acquired in the city of São Miguel, Tocantins state. In the laboratory, the almonds were processed and the press cake residual was obtained and used for obtaining water-soluble extract and product powders.

Extract Powders and Cookies Preparation

The water-soluble extract was obtained through the homogenization of 250 grams of pie with water distilled (2:1). After, the mixture was filtered with a fabric filter to the removal of large-sized solid particles that can cause damage to the dryer nozzle. The filtrate, water-soluble extract, was encapsulated and dried. The extract was mixed with an encapsulating agent 18% (Maltogill®10) using the homogenizer Fisatom model 712 at 1000 rpm for 5 min. After, the solution was dried by a spray dryer (LM MSD 0.5 Labmaq, Brazil) with a pneumatic nozzle of 1.2 mm, with feed flow rate of 0.2 L/h, air flow rate of 1.71 m³/min, and drying air velocity of 30L/min. The final product was packaged in plastic packaging and stored in desiccators until the preparation of the cookies.

Three cookies formulations were prepared with different concentrations of babassu extracts obtained (5%, 15%, and 25%) in the replacement of wheat flour without yeast. . These proportions were established after preliminary sensory tests and are Table 1 shows.

Table 1- Formulations used in the preparation of cookies.

Ingredient (%)	F 1 (5%)	F 2 (15%)	F 3 (25%)
wheat flour	47.43	42.44	37.44
Babassu extract powder	2.50	7.49	12.48
Margarine	24.96	24.96	24.96
Sugar	24.96	24.96	24.96
Yeast	0.15	0.15	0.15
Total	100.0	100.0	100.0

Source: Research Data (2020).

After the definition of concentrations and inputs used in the preparation of the cookies (Table 1), all ingredients were weighed and mixed until the dough formed. Then, the cookies were modeled and baked at 160 °C for 30 min. After baking, the cookies were cooled at room temperature (25 °C) and stored in plastic bags.

Physical-chemical Characterizing of the Extract and Cookies

The composition centesimal of extract and cookies and the pH, acidity, and total solids (°Brix) of the extract was realized according to AOAC (2005) and IAL (2008): the moisture by straight drying at 105 °C, protein by the Kjeldahl method, lipids by straight extraction in Soxhlet, and ashes by the incineration in muffle (temperature). All analysis was done in triplicates. The carbohydrates content was determined by difference.

Microbiological Evaluation

The evaluation of the microbiological quality of the cookies made with extract powder of babassu coconut almond pie was realized by thermotolerant coliforms (at 45°C), *Salmonella sp.*, and *Staphylococcus aureus* analysis according to Silva (2001) and (ANVISA, 2001).

Sensory Evaluation

This study was approved by the Ethics Committee of the Universidade Federal do Tocantins, Brazil (protocol no. 037/2015). All assessors filled and assigned the Free and Informed Consent Term before starting the tests. The sensory analysis was performed using

descriptive test (Quantitative Descriptive Analysis – ADQ) and affective test (acceptance test and purchase intention).

Descriptive test ADQ

The descriptive test was carried out according to the adapted methodology of Stone and Sidel (1993). Eight assessors, of all sexes and ages, were selected by individual interview and questionnaires about possible allergies or intolerances such as gluten, diseases such as diabetes, and the interest in contributing to the research. Besides, aroma and taste recognition tests were used for selection of assessors. In aroma recognition test were selected the assessors that recognized more of 70% of 16 different aromas. But, in taste recognition test was selected the assessors that recognition 100% of solutions of sweet, salty, acid, and bitter tastes. Finally, the characteristics of texture and cookies identification were related.

The development of the descriptive terminology defined the following attributes: color, crispness, sweetness, softness, buttery cookies aroma, babassu extract aroma, buttery cookies taste, and babassu extract taste. The intensity of each attribute was fixed on a scale of 10 cm with extremes defined of imperceptible to very intense.

The assessors received the three samples of cookies elaborated with different concentrations of extract powder of babassu pie, randomly numbered with three digits. The assessors also received a glass with water and a water cookie to clean the palate. Besides, the assessors were instructed to fill the evaluation forms with their evaluations of the attributes determined in the descriptive terminology.

Affective test

The affective test was accomplished with 50 untrained tasters of all sexes and ages, selected due to preference and regular consumption of cookies. The tasters randomly received the three cookies samples encoded with three numbers, together with a glass with water and salt crackers. Tasters also received forms containing a hedonic scale with nine points between “I liked it extremely” and “I disliked it extremely” for the attributes color, taste, aroma, and texture. The assessors indicated your intention to purchase in the seven-point categories, ranging from “I would never buy” (1) to “I would always buy” (7).

The acceptability index of cookies was obtained by Equation 1, which A = average grade obtained for the products and B = maximum grade given the product. For this result to be positive, it is necessary to obtain at least 70% acceptance (Dutcosky, 1996).

$$AI (\%) = \frac{A \times 100}{B} \quad (1)$$

Statistical analysis

Data were analyzed using Analysis of Variance (ANOVA) with Tukey test at 5% significance for averages evaluation by ASSISTAT® Software 7.7.

3. Results

Physical-chemical characterizing

The centesimal composition of water-soluble extract powder of babassu pie and cookies are shown in Table 2.

Table 2 – Physical-chemical characterization of extract and cookies.

Constituents	Water-soluble extract	F1 (5%)	F2 (15%)	F3 (25%)
Moisture (%)	90.51±1.15	2.58±0.01 ^a	2.30 ±0.01	2.19±0,01 ^c
Protein (%)	0.99±0.05	2.99±0.10 ^a	2.90±0.02 ^a	2.75±0.05 ^a
Lipids (%)	7.74±0.72	26.12±0.01 ^c	26.51 ±0.01 ^b	26.89 ±0.01 ^a
Ashes (%)	0.27±0.01	0.68±0.01 ^a	0.63 ± 0.01 ^b	0.46± 0.04 ^c
Carbohydrates (%)	0.49±0.26	67.63	67.66	67.71
pH	6.80±0.10	n/a	n/a	n/a
Acidity	0.51±0.01	n/a	n/a	n/a
Total soluble solids (Brix ⁰)	3.35±0.01	n/a	n/a	n/a

*Different letters on the same line differ significantly by the Tukey test ($p \leq 0.05$); n/a not analysed.
 Source: Research Data (2020).

The average and the standard deviation of physical-chemical characterization results of babassu coconut almond pie extract and the cookies elaborated are shown in Table 2.

Microbiological analysis

The results of microbiological analysis (Table 3) of cookies made with babassu extract powders were compared with the Standards by RDC n° 12 (January 2, 2001) of the National Health Surveillance Agency – ANVISA.

Table 3- Microbiological quality of cookies.

Analyze	cookies			(BRASIL, 2001)
	F1	F2	F3	
Coliforms at 45°C (NMP/g)	< 3	< 3	< 3	10/g (Max.)
S. aureus (UFC/g)	< 10 ²	< 10 ²	< 10 ²	5x10 ² /g (Max.)
Salmonella sp. (in 25g)	Absent	Absent	Absent	Absent in 25g (Max.)

* NMP- Most Likely Number per gram.

* UFC- Cologne forming unit per gram.

Source: Research Data (2020).

The microbiological results of the cookies are accord to the established parameters by the Brazilian legislation (Table 3).

Sensory characteristics

Descriptive test (ADQ)

The ADQ results of the cookies samples are shown in Table 4.

Table 4- Sensory attributes of the cookies samples by the Quantitative Descriptive Analysis.

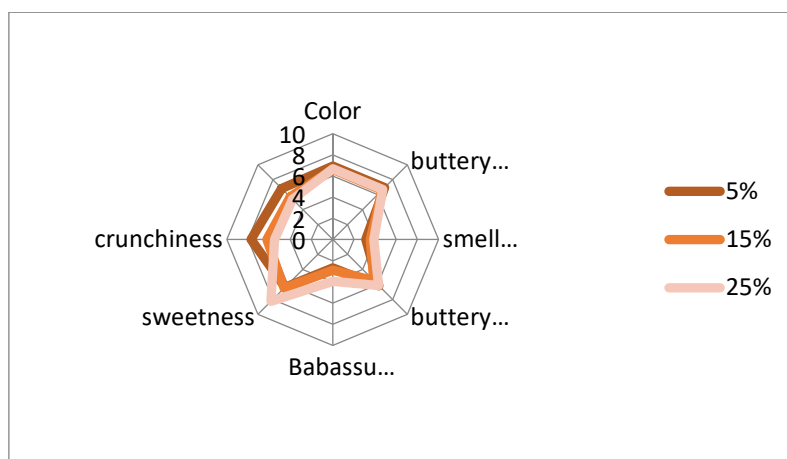
Attributes	F1 (5%)	F2 (15%)	F3 (25%)
Color	6.93 ^a	6.63 ^a	6.69 ^a
Crunchiness	7.4 ^a	6.06 ^a	5.44 ^a
Sweetness	6.4 ^b	6.50 ^b	8.25 ^a
Softness	6.8 ^a	5.69 ^a	5.38 ^a
Buttery biscuit aroma	6.9 ^a	6.63 ^a	6.69 ^a
Babassu extract aroma	3.12 ^a	3.56 ^a	3.56 ^a
Buttery biscuit taste	6.18 ^a	5.50 ^a	6.13 ^a
Babassu extract taste	2.69 ^a	2.88 ^a	3.94 ^a

*Different letters on the same line differ significantly by the Tukey test ($p \leq 0.05$)

Source: Research Data (2020).

Only the sweetness attribute in the sample with 25% formulation presented statistical difference at 95% confidence level by Tukey test as shown in Table 4. The sensory descriptors configuration of cookies samples is represented in Figure 1.

Figure 1 – Configuration of sensory descriptors of cookies.



Source: Research Data (2020).

Figure 1 contains the sensory attributes configuration of cookies made of powders of babassu almond pie extract, in which the concentration of 25% presented the highest sweetness attribute. That result is coherent with previously showed data.

Affective test

The Affective test results of the cookies samples are shown in Table 5.

Table 5- Affective test results of the cookies samples.

Attributes	F1 (5%)	F2 (15%)	F3 (25%)
Color	8.16 ^a	8.24 ^a	8.04 ^a
Aroma	7.70 ^a	8.12 ^a	7.84 ^a
Taste	8.00 ^a	8.20 ^a	7.68 ^a
Texture	7.96 ^a	7.68 ^a	7.42 ^a

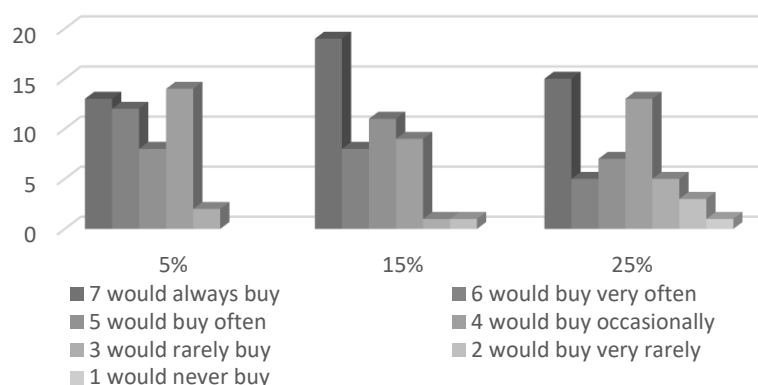
*Different letters on the same line differ significantly by the Tukey test ($p \leq 0.05$)

Source: Research Data (2020).

The results of the affective test showed that there was no significant difference ($p > 0.05$) between the samples for all attributes evaluated (Table 5). All attributes presented good scores, finding between 7 (I liked it regularly) to 8 (I liked it moderately) hedonic term.

The scores obtained for the purchase intention of the cookies samples (5%, 15%, and 25%) are shown in Figure 2.

Figure 2- Frequency histograms of the scores attributed to the purchase intention of the babassu extract cookies.



Source: Research Data (2020).

The histograms in Figure 2 showed that all formulation evaluated had good acceptance. However, the cookies with 15% of powders extract presented better acceptance by the tasters.

The purchase intention and acceptability index results are shown in Table 6.

Table 6- Purchase intention and Acceptability Index of babassu extract cookies.

Formulation	Purchase intention	Acceptability Index (AI%)
F1 (5%)	5.40 ^a	77.14
F2 (15%)	5.66 ^a	80.86
F3 (25%)	5.02 ^a	71.71

*Same letters on the same column no differ significantly by the Tukey test ($p \leq 0.05$).
 Source: Research Data (2020).

The three samples no presented statistical difference with significance level of 95% between them to Purchase intention as shown in Table 6. Besides, the acceptability index (AI) showed that all samples were well accepted, but the sample with 15% of extract presented higher AI than the other ones.

4. Discussion

Physical-chemical characterizing

The centesimal composition results show that moisture and lipids are the main components in the water-soluble extract. This behavior was already expected due to found by Santana (2013) also in coconut babassu extract. However, the values her found were higher (78.31% of moisture and 18.97% of lipids), which is coherent since this extract was obtained directly from babassu almond. The babassu almond is rich in oil, justifying the result found. But the ash values (0.27%), total carbohydrates (0.45%), pH (6.6) and acidity (0.61%) were similar to found in this study. The pH and acidity values obtained show the necessity of alternative technologies for product conservation, bearing in mind that they fit in products with low acidity (pH 5.5 and 7.5).

The centesimal composition values of extract were close to found by human milk: 0.93% of protein, 0.15% of ashes, and 4.07% of lipids (Souza e Silva, 2010). Human milk is considered nutritive since this is essential for grown and development of children (Garwolińska, Namieśnik, Kot-Wasik and Hewelt-Belka, 2018). Thus, babassu extract can be considered a nutritive product.

For the cookies obtained, the moisture values presented statistically (95%) significant difference. However, all presented accord to the recommended parameters for cookies (< 14%) (Brasil, 2005). The lipids, ashes, and carbohydrates contents also presented statistic differences for all cookies. However, the protein contents no presented statistically different from each other and were lower to the found by enriched cookie with passion and cassava starch flours (2.65%) (Santana et al., 2011).

The lipids value presented increase proportional to the increase of the extract powder concentration. This result is expected since the extract obtained presented 7.74% of lipids, value higher than the wheat flour (about 0.7g/50g) that has been replaced. The increase of lipids contents can be positive since the almonds present high values of unsaturated fatty acids that have beneficial health effects. Thus, these acids contents can increase after add of babassu almond extract. Marquetti (2014) also found an increase in lipids contents after add jabuticaba peel flours in cookies. The increase of unsaturated and poly-unsaturated fats is beneficial since its value exceeds the value of saturated and trans fats present in margarine. The margarine adds in cookies are frequent. Thus, the increase of benefic health fat in this product is a differential

(Ledo, Chaud & Abreu, 2019). Future studies of fatty acids in cookies of babassu almond extract must be analyzed.

The ashes values are lower than found to cookies made with babassu mesocarp flour (1.09 – 1.19%) (Silva, Barros, Pereira, Lemos & Abreu, 2019), but the babassu mesocarp and almond presented different centesimal composition. However, the ashes values found are accord to Brazilian legislation for cookies (max. 3%) (Brasil, 2005). For carbohydrates values, the F1 and F2 samples presented lower value than the F3 sample with a small variation. It was observed that there was an increase in the carbohydrate content when increasing the concentration of powdered extract, which can be justified by the addition of the carrier agent in the atomization process.

Microbiological quality

All cookies made with extract powder of babassu pie are accord with the limits established for microbiological quality by Brazilian legislation. Thus, the cookies produced are suitable for consumption.

Sensory characteristics

Descriptive test (ADQ)

In all the sensory descriptors of ADQ, the only one that showed a statistical difference between the samples was sweetness (p 0.0159), in this attribute, the intensity of the sweet taste was verified, the results showed that there was no significant difference between the formulations with 5% and 15% powder extract from the residual babassu coconut almonds pie, however, they differed from the formulation with 25%, this fact is due to the increase in the powder extract concentration, it has a sweet flavor due to presence of the carrier agent (Maltogill®10), which justifies the result found and supports the results obtained in the proximate composition of the cookies.

It is well known that the descriptor sweetness in the concentration of 25% of powdered extract stands out concerning other formulations. As well as the crunchiness, it is related to the ease of breaking in the first bite, and although there was no statistical difference between the formulations, it is noted that the sample with 5% of powder extract showed a higher average

(7,4) when comparing formulations with 15% and 25% presenting 6.06% and 5.44% respectively, the same was observed for softness.

This behavior may have occurred due to the size of the sucrose used together with the concentration of powdered extract, as mentioned, it has Maltogill®10 in its composition, obtaining a mixture of saccharides, formed by D-glucose units, thus their presence tends to crystallize in cookies when cold, elucidating the results obtained. According to Moraes, Zavareze, Miranda and Salas-Mellado (2010) the fine granulometry of the sugars leaves the cookies crunchy, corroborating the results obtained in the present study.

With regard to aroma and flavor, the greater intensity was observed with the increase in the concentration of the extract, however, the level of perception was low (averages between 3.12-3.56 and 2.69-3.94), This behavior may be due to the atomization process, where it may have caused the loss of possible volatile compounds present in the sample. Carmo, Fernandez and Borges (2015) point out that this technique can lead to the loss of these compounds.

Affective test

The cookies were well accepted by assessors with grades varying in hedonic terms of 7 (I liked it regularly) to 8 (I liked it moderately) for all attributes evaluated. Besides, no significant differences were observed between the formulations evaluated. Thus, all levels of babassu extract (5, 15, or 25%) added will provide cookies with satisfactory acceptance.

The purchase intention showed good acceptance for the three formulations evaluated without difference significantly at the 95% confidence level. However, the F2 cookie presented greater acceptance (18 %). For a product to be considered accepted by sensory attributes, it must obtain at least 70% of acceptability (Dutcosky, 1996). Thus, all formulations evaluated are considered accepted by consumers.

Purchase intention allows verifying the desire of consumers to buy or not the product. The results obtained refer to score 5 (I would buy frequently). Thus, this result proves the found in the affective test. These results show that the production of cookies made with babassu residual extract is viable, being an alternative for these by-product use.

5. Final Considerations

The spray dryer process allows us to obtain extract powders of the babassu coconut almond pie. In this research, We found that it is possible to use the extract powder for

application in bakery products such as cookies, with satisfactory physical-chemical and microbiological parameters, and in compliance with current legislation, as well as results similar to other studies with the same approach. The sensory analysis showed good acceptance by the tasters, especially for cookie with 15% extract powder. Thus, cookies produced with extract powders from the babassu pie can be considered viable and still be an alternative to add value to the product.

This study contributes to improving the babassu research, since yet scarce in literature. Thus, we suggest that future studies evaluate the application of babassu almond extract in other food products and its physical-chemical and sensory properties with attention to the presence of essential fatty acids such as lauric acid since its beneficial for health is consolidated by academic community.

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