*Asian Food Science Journal*

***Volume 23, Issue 12, Page 73-81, 2024; Article no.AFSJ.127612***
***ISSN: 2581-7752***

# Cookies with Functional Ingredients: Effect of Adding Powdered Passion Fruit Albedo on the Physical-chemical Characteristics and Sensory Attributes of Cookies Sweetened with Xylitol

**Carlos Victor Bessa Corrêa [a*], Jerusa Souza Andrade [b] and Lidia Medina Araújo [c]**

*[a] Universidade do Estado de Amazonas, Brazil.*
*[b] Universidade Nilton Lins, Brazil.*
*[c] Universidade Federal do Amazonas, Brazil.*

***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

***Article Information***

DOI: https://doi.org/10.9734/afsj/2024/v23i12759

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/127612

***Original Research Article***

***Received: 04/10/2024***
***Accepted: 08/12/2024***
***Published: 11/12/2024***

## ABSTRACT

**Introduction:** This paper studied nutritionally enhanced cookies, especially those containing dietary fiber and other health-promoting active substances. The addition of Xylitol, which is used as a sweetener and preservative as an ingredient during cookie production to extend the shelf life of cookies, also plays an important role in ensuring food and nutritional safety.

**Corresponding author: Email: crcorrea@uea.edu.br;*

***Cite as:*** *Corrêa, Carlos Victor Bessa, Jerusa Souza Andrade, and Lidia Medina Araújo. 2024. "Cookies With Functional Ingredients: Effect of Adding Powdered Passion Fruit Albedo on the Physical-Chemical Characteristics and Sensory Attributes of Cookies Sweetened With Xylitol". Asian Food Science Journal 23 (12):73-81. https://doi.org/10.9734/afsj/2024/v23i12759.*

**Aims:** The aim of this study was to elaborate and evaluate the physical-chemical and sensorial characteristics of cookies enriched with powdered passion fruit albedo (*Passiflora edulis* f. flavicarpa) and sweetened with xylitol.
**Study Design:** This research involved the development of cookie formulations with varying concentrations of powdered passion fruit albedo and subsequent evaluation of their proximate composition, texture, water activity, soluble solids, pH, pectin content, and sensory attributes.
**Place and Duration of Study:** The study was conducted in Brazil over a period of several months, encompassing both the experimental development of the cookie formulations and the laboratory analyses.
**Methodology:** The cookie samples were prepared with a control formulation and variations containing 3%, 6%, 9%, and 12% powdered passion fruit albedo, all sweetened with 10% xylitol. The cookies were assessed for proximate composition (moisture, lipids, proteins, fiber, ash, and carbohydrates), texture, water activity, soluble solids, pH, pectin content, and sensory characteristics.
**Results:** The incorporation of powdered passion fruit albedo significantly influenced the characteristics of the cookies. Higher concentrations (6% to 12%) adversely affected texture and acceptability. The optimal concentration was found to be 3%, which resulted in cookies with increased moisture, protein, fiber, pectin, and ash content, reduced lipids, carbohydrates, and calories, improved texture, and higher acceptability (71.43%).
**Conclusion:** Cookies sweetened with xylitol and enriched with 3% powdered passion fruit albedo presented the best balance of physical-chemical and sensory properties, making them a viable option for producing functional foods with improved nutritional benefits.

*Keywords: Physicochemical analysis; sensory analysis; texture; water activity.*

## 1. INTRODUCTION

The biscuit industries produce on a large scale and these products vary in format and flavors, they can be sweet or savory, with or without filling. According to Brazilian legislation (ANVISA, 1978), biscuits can be obtained from flour, starch and other food substances and the products are called biscuit, "bolacha" or cookies followed by the substance that characterizes it. Most cookies have a high content of hydrogenated fats, low fiber content and high caloric value, and thus contribute to obesity, increased cholesterol and triglyceride levels, being one of the causes of cardiovascular diseases and diabetes (Faustin et al., 2007).

Due to concerns about consumers' health, the incorporation of functional ingredients into food products has grown in recent decades; among these ingredients are dietary fibers, sweeteners, essential fatty acids, vitamins and mineral salts (Tonato, 2007). Fibers are classified as soluble and insoluble and are identified as bioactive substances, which promote health. The soluble fraction of dietary fiber is composed of gums, mucilages, pectic substances and other soluble polysaccharides, and absorbs water forming the gel, promoting satiety and improving intestinal transit. The insoluble fraction, on the other hand, is composed of cellulose, lignin and hemicellulose, being responsible for the formation of fecal cake and for increasing the peristaltic action of the intestine (Anjo, 2004). Thus, dietary fiber influences various aspects of digestion, which is why it is included in dietary plans for the prevention or treatment of diabetes, hypercholesterolemia, constipation and obesity. Dietary fiber deficiency may be related to the development of colon cancer and other gastrointestinal disorders (Calixto, 1993).

The pectic substances of the soluble fraction and the lignocellulosic components of the insoluble fraction of the fibers are present in fruit peels. These peels are agro-industrial waste discarded by fruit processing industries. The adequate use of these agro-industrial residues can generate ingredients for several products for food purposes with benefits (Pereira et al., 2005).

In Brazil there is a large production of tropical fruits, and among them, passion fruit surpasses that of mango, guava and papaya. As the country is one of the largest exporters of concentrated juices, adding value to these by-products from agro-industrial waste is of environmental, economic, scientific and technological interest (Cordová et al., 2005).

Passion fruit is one of the fruits in the production chain in the Amazon region, where its harvest occurs from December to July. In Brazil, passion fruit juice processing industries generate large amounts of waste, since about 60% of the total weight of the fruit corresponds to waste (peel and seeds). Throughout Brazil, this disposal represents countless tons that are wasted and that could be used (Ferrari & Ayub, 2004).

The residue (passion fruit peel) has been studied about its nutritional importance and its use as a functional food. The albedo (white part of the passion fruit peel) after being dehydrated contains (on average) 6.65% moisture, 8.68% ash, 0.80% lipids, 26.41% total fiber, 1.50 % protein and 55.96% usable carbohydrates (AOAC, 1997). The parameters of pH, soluble solids, pectin and total sugars are, r espectively, 4.45, 4.67 ºBrix, 2.3% and 1.24% (Araújo, 2007).

In the Amazonas (Brazil), passion fruit peel is an industrial residue generated from processing the fruit and can be used; the albedo is extracted, fractionated, successively washed, dehydrated and ground. This dehydrated product is already known for its high content of dietary fiber, being yet another alternative ingredient to be incorporated in the preparation of biscuits, resulting in an enriched product with functional properties (Araújo, 2007). In other countries, nutritional evaluation of cookies with different levels of Rosehip and Hibiscus Powder Substitution (Antarkar et al., 2019) and cookies from Sprouted Sorghum, Pigeon Pea and Orange Fleshed Sweet Potato Flour Blends was conducted (Bello et al., 2020).

Among the functional ingredients, the sweetener xylitol has been used in industrialized products. Xylitol is approved in over forty countries and used in the food, pharmaceutical and cosmetic industries. In Brazil, the industrialized products that use xylitol are chewing gum, candies, confectionery, jellies, caramels, toothpastes, chocolates, desserts and puddings (Mussato & Roberto, 2008).

One of the advantages of using xylitol over sucrose is its chemical and microbiological stability, in addition to being anticariogenic. Xylitol acts as a preservative and hinders the growth of microorganisms, prolonging the shelf life of food products. Another important property of xylitol is its reduced caloric value, with only 2.4 kcal/g compared to sucrose, which has 4 kcal/g (Bar, 1991).

This work aimed to develop cookies enriched with powdered passion fruit albedo and sweetened with xylitol, and to evaluate the physical, physicochemical and sensory characteristics to obtain a food with functional properties.

## 2. MATERIALS AND METHODS

### 2.1 Materials

The ingredients were purchased at the market in the city of Manaus (Amazonas, Brazil). Xylitol was purchased from Tovani Ltda® (São Paulo, Brazil). The passion fruit peels came from homemade pulp production industries in the metropolitan region of Manaus. The powdered passion fruit albedo was obtained as described by Araujo (2007).

### 2.2 Cookies Preparation

The basic formulation for the production of cookies followed the procedure described by Moretto & Fett (1991), however, the hydrogenated fat was replaced by vegetable oil. The ingredients and their respective amounts are shown in Table 1. The standard cookie (0%) was not added with powdered passion fruit albedo. First, all the dry ingredients were mixed (wheat flour, corn starch, soy lecithin, powdered passion fruit albedo, baking powder, xylitol and salt). Then the liquid ingredients (drinking water, oil and passion fruit essence) were added. The homogenization was carried out for five minutes (with a Lieme® brand kneader) until the point of cylindering. After resting for 15 minutes at room temperature, the dough was processed on a flat bench. The dough was rolled out with cylinder to a thickness of 1 cm. The cut was made with a circular modeler and the cookies were baked at a temperature of 150 ºC for 30 minutes. After baking, the cookies were packed in flexible plastic packaging.

**Table 1. Ingredients and their quantities used in the preparation of cookies incorporated with powdered passion fruit albedo and sweetened with xylitol**

| Ingredients | Formulations and amounts (%) | | | | |
|---|---|---|---|---|---|
| | **0** | **3** | **6** | **9** | **12** |
| Wheat flour (gr) | 100 | 97 | 94 | 91 | 88 |
| Powdered passion fruit albedo (gr) | 0 | 3 | 6 | 9 | 18 |
| Corn starch (gr) | 20 | 20 | 20 | 20 | 20 |
| Chemical yeast (gr) | 1 | 1 | 1 | 1 | 1 |
| Soybean oil (mL) | 20 | 20 | 20 | 20 | 20 |
| Xylitol (gr) | 10 | 10 | 10 | 10 | 10 |
| Water (ml) | 25 | 25 | 25 | 25 | 25 |
| Soy lecithin (gr) | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Passion fruit essence (ml) | 1 | 1 | 1 | 1 | 1 |
| Salt (gr) | 1 | 1 | 1 | 1 | 1 |

## 2.3 Physical-chemical Characterization

A sample of 20 units was individually evaluated for weight (measured before and after baking), thickness according as Ferreira (AOAC, 1997) and texture. The thickness (height) was measured with a caliper (HELIOS STAINLLES®) and the data were expressed in cm. The texture was determined on a Stable Micro Systems® texturometer, model TA-XT2, using probe number 4, a distance of 40 mm and the speeds of the pre-test of 2 mm/s, of the test of 5 mm/s and of the post-test of 5 mm/s. The water activity was determined in a Tecnal® equipment (according to the manufacturer's specifications), the pH in a digital potentiometer and the soluble solids (with dilution in water and use of the correction factor) by refractometry.

The centesimal composition was determined according to AOAC (Pereira et al., 2005) Moisture content was obtained by desiccation (65 ºC oven) to constant weight. The ash content was determined by muffle incineration at 550 ºC, the lipid content by extraction with hexane in a Soxhlet apparatus and the total fiber content by the Weende method. The total nitrogen content was determined by the micro-Kjeldhal method and the factor 6.25 was used to convert total N into protein. Alcohol-insoluble solids (AIS) were determined according to Ahmed & Lavittch (1977). Pectins were determined from the AIS fraction by the carbazole method described by Southgate (1991). Metabolizable carbohydrates were estimated *[100 - (moisture + proteins + lipids + fibers + ash)]* and the results were expressed in g/100g of whole sample. For the caloric value, the coefficients of ATWATER 4, 9 and 4 Kcal/g of protein, lipids and carbohydrates, respectively (Taco, 2006) were used.

## 2.4 Sensory Analysis

Sensory analysis was carried out at the Food Technology Department of the National Institute for Amazonian Research (INPA). A group of 51 untrained tasters (students and INPA employees) performed the analysis. Tasters used a form for the preference test and the structured hedonic scale from 1 to 7 points (Anzaldúa, 1994).

## 2.5 Statistical Analysis

The experimental design was completely randomized, with five treatments and three replications. Data were subjected to analysis of variance (ANOVA) and means were compared by Tukey's test at 5% significance, using the ASSISTAT 2010 program.

# 3. RESULTS AND DISCUSSION

## 3.1 Physical and Physicochemical Characteristics

Table 2 shows the average results (*n=20*) of the physical analyzes of the cookies produced with different concentrations of powdered passion fruit albedo and sweetened with xylitol. Before baking, the cookies did not differ statistically ($p > 0.05$), demonstrating homogeneity in weight. However, after baking, significant differences were detected. After baking, the average weight of the cookies incorporated with larger amounts (6, 9 and 12%) differed significantly from the others (control and 3%).

Regarding the texture of the cookies, all samples differed significantly from each other. The force required to break the cookies was greater for the 12% formulation, which had a very hard texture

after baking, exceeding the capacity of the equipment used. Softer texture was observed in the control cookie (Table 2). According to Bar, (1991), the texture is influenced by the granulometry of the sugars and the amount of fiber. As shown in Fig. 1, the increase in the addition of passion fruit albedo powder directly influenced the hardness of the cookies.

The thickness data of the five types of cookies did not differ from each other (Table 2). Although there was no significant difference, it was observed that the thickness tended to decrease as the concentration of powdered passion fruit albedo increased. The addition of large amounts of fiber interfered with the formation of the gluten network, growth and softness of the cookies. The fiber containing pectin probably caused the dough to undergo less expansion (growth) during the baking process. The results obtained in this work have a similar behavior to that found by Souza (2001), who worked with the processing of cookies enriched with Brazil nuts. Thus, the lowest proportion (3%) of powdered passion fruit albedo had the least negative influence on the growth of cookies.

The pH values for cookies are close to the normal range for cookies in general, which is 6.0 to 8.0, as reported by García-Baños et al. (2004) who evaluated crackers and commercial cookies and found similar pH values. Moisture and water activity increased as a function of the increase of powdered passion fruit albedo. The maximum average of the water activity values was 0.53 (12% of the powdered passion fruit albedo). With low water activity, it is possible to prevent microbiological degradation by establishing a manual of good handling practices, determining conservation methods and choosing the types of packaging. In general, the cookies produced in the industry have residual moisture in the range of 3 to 4% Vitti et al. (1988). The highest moisture contents found were found in cookies with 12, 9 and 6% in relation to the standard, and this can be attributed to greater water retention due to the greater amount of fiber. For moisture, statistical analysis showed that cookies with 3, 6, 9, and 12% did not differ from each other ($p>0.05$). However, the control cookie showed a significant difference at the 5% level. The soluble solids (°Brix) determined by Valença et al. (2008) are close to the values found in the present work (Table 2).

Pectin statistically showed variation between cookies made with 3% and 12% of powdered passion fruit albedo (Table 3). This variation shows that as the albedo concentration increased, the amount of pectin in the product increased. Due to the presence of other dough components, the amount of pectin found in cookies is slightly lower than that found by Araújo (2007) and Machado et al. (2003) when they quantified pectin in passion fruit albedo.

The ash content increased depending on the amount of added albedo (Table 3) and the data differed from each other at the 5% level. The average value of ash content in cookies is similar to that found by Maciel et al. (2008), who in their studies found approximate values (1.90±0.02 and 2.50±0.03) in cookies made with the addition of linseed flour. However, it is lower than that found by Silva et al. (2005), who in their studies used “Jatobá” flour (*Hymenaea stigonocarpa* Mart.) in cookies. Moisture and ash in all cookies presented data within the range of maximum and minimum values allowed by Brazilian legislation, which are 14% and 3%, respectively (Silva et al., 1998).

There was an increase in protein content in the formulations added with powdered passion fruit albedo when compared to the standard cookie (control). There was no significant difference of 5% variance between samples regarding the amount of proteins; however, the data showed that formulations 3, 6, 9, 12% did not differ from each other (Table 3). The average protein value found in the cookie with powdered passion fruit albedo is close to that found in the biscuit produced with casein and sodium caseinate by Kruger et al. (2003). In this work, the protein content is higher than that found (4.30%) in cookies with loquat seed flour studied by Mussato & Roberto, (2008), and that found (6.2%) in cookies with jatobá flour studied by Guilherme & Jokl, (2005).

The percentages of lipids found in cookies with powdered passion fruit albedo were lower than the standard cookie (control). The data showed a significant difference regarding the amount of lipids at a significance level of 5% (Table 3). Variations occurred between the cookies formulations with 3 and 12% added albedo. It is important to emphasize that the average values found in this study are similar to those of the cracker biscuit with flaxseed flour studied by Maciel et al. (2008), and lower than those found in the biscuit with bacuri peel studied by Valença

et al. (2008). Currently, most commercial biscuits have high levels of hydrogenated vegetable fat, which are predisposing to the development of coronary heart disease and high cholesterol.

Dietary fiber varied significantly among all formulations (Table 3). The values found in this work were close to the values found in cookies made with cornmeal (Guilherme & Jokl, 2005). According to the Brazilian Ministry of Health (1978), foods can be considered as sources of fiber (when they contain a minimum of 3 g/100 g of fiber), or as high in fiber (when they contain a minimum of 6 g /100 g of fibers). Thus, the cookie with 3% replacement of wheat flour by powdered passion fruit albedo can be considered a source of fiber, and the others (6%, 9%, and 12%) as having a high fiber content.

A significant difference was observed between the standard cookies and the other formulations for carbohydrates (metabolizable carbohydrates). The carbohydrate data found in this work were close to that found in the biscuit with "jatobá" flour (Silva, 1997).

The caloric value is a parameter that involves the contents of proteins, carbohydrates and lipids, being of interest in the control of ingested calories. The caloric value showed a significant difference between them at the 5% level (Table 3). In all formulations, there was a reduction in caloric value, due to the increase in the incorporation with powdered passion fruit albedo. When compared with the values of biscuits formulated with sucrose, xylitol is a low-calorie sweetener (2.4 kcal/g) when compared to sucrose (4 kcal/g) (Bar, 1991). In cookies prepared with powdered passion fruit albedo and sweetened with xylitol, carbohydrates are the main source of calories and contribute 59 to 65%, lipids contribute 24 to 30% and proteins only 11%. The addition of powdered passion fruit albedo reduced the amount of calories in the cookies. Compared to the standard cookie (without powdered passion fruit albedo), the reductions were 12.5%, 13.3%, 14.6% and 20.2%.

**Table 2. Physical and physicochemical characteristics of cookies prepared with powdered passion fruit albedo and sweetened with xylitol**

| Physical and physicochemical parameters (*n=20*) | Amounts of powdered passion fruit albedo (%) | | | | |
|---|---|---|---|---|---|
| | **0** | **3** | **6** | **9** | **12** |
| Pre-baked weight (gr) | 3.96±0.11$^{a}$ | 3.89±0.67$^{a}$ | 3.63±0.14$^{a}$ | 3.59±0.45$^{a}$ | 3.45±0.11$^{a}$ |
| Post-bakes weight (gr) | 2.91±0.34$^{a}$ | 2.87±0.25$^{a}$ | 2.54±0.17$^{b}$ | 2.52±0.12$^{b}$ | 2.44±0.09$^{c}$ |
| Texture (N) | 16.43±0.4$^{d}$ | 23.62±0.79$^{c}$ | 33.65±0.94$^{b}$ | 41.26±0.27$^{a}$ | Nd |
| Height (cm) | 1.5±0.20$^{a}$ | 1.3± 0.07$^{a}$ | 1.1 ± 00.6$^{a}$ | 1.0 ±0.05$^{a}$ | 0.9 ±0.12$^{a}$ |
| Water activity | 0.49±0.3$^{b}$ | 0.51±0.03$^{b}$ | 0.50±0.12$^{b}$ | 0.52±0.23$^{a}$ | 0.53±0.15$^{a}$ |
| Moisture (%) | 4.56±0.12$^{c}$ | 5.91±0.06$^{b}$ | 6.22±0.37$^{ab}$ | 6.39±0.26$^{ab}$ | 6.6±0.13$^{a}$ |
| pH | 6.0±0.54$^{a}$ | 6.0±0.18$^{a}$ | 5.8 ±0.34$^{b}$ | 5.7±0.12$^{b}$ | 5.5±0.37$^{c}$ |
| Soluble solids (°Brix) | 9.5±0.33$^{a}$ | 9.0±0.11$^{a}$ | 9.5 ±0.24$^{a}$ | 9.5±0.22$^{a}$ | 9.5±0.45$^{a}$ |

*Nd = Not determined. Means with equal letters on the same line do not differ from each other (p>0.05) by the Tukey test*

**Table 3. Nutritional and bioactive components and caloric value of cookies prepared with powdered passion fruit albedo and sweetened with xylitol**

| Components | Amounts of powdered passion fruit albedo (%) | | | | |
|---|---|---|---|---|---|
| | **0** | **3** | **6** | **9** | **12** |
| Proteins (%) | 6.86±0.43$^{b}$ | 10.32±0.09$^{a}$ | 10.08±0.74$^{a}$ | 10.17±0.85$^{a}$ | 10.05±0.82$^{a}$ |
| Lipids (%) | 16.34±0.47$^{a}$ | 10.41±0.19$^{d}$ | 10.64±0.67$^{c}$ | 11.61±0.28$^{b}$ | 11.69±0.12$^{b}$ |
| Fiber (%) | 3.6±0.74$^{d}$ | 8.47±0.45$^{c}$ | 9.06±0.54$^{c}$ | 11.54±1.08$^{b}$ | 17.43±0.54$^{a}$ |
| Pectin (%) | Nd | 1.75±0.01$^{a}$ | 1.82±0.03$^{a}$ | 1.82±0.01$^{a}$ | 2.12±0.02$^{b}$ |
| Ash (%) | 1.95±0.34$^{c}$ | 2.12±0.13$^{b}$ | 2.24±0.05$^{b}$ | 2.36±0.13$^{b}$ | 2.63±0.01$^{a}$ |
| Carbohydrates (%) | 66.69±0.58$^{a}$ | 62.77±0.13$^{b}$ | 61.76±0.43$^{b}$ | 57.93±0.09$^{c}$ | 51.6±0.56$^{d}$ |
| Caloric value (Kcal) | 441±0.6$^{a}$ | 386±0.3$^{b}$ | 383±0.5$^{b}$ | 377±0.1$^{c}$ | 352±0.2$^{d}$ |

*Nd = Not determined. Means with equal letters on the same line do not differ from each other (p>0.05) by the Tukey test*

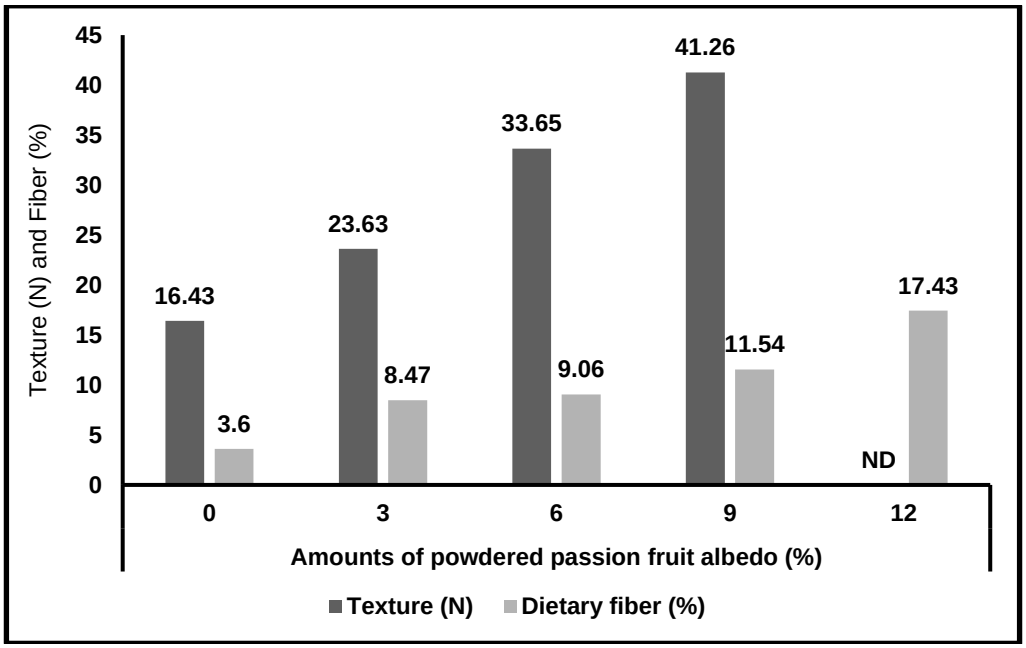


**Fig. 1. Effect of adding powdered passion fruit albedo on the texture and the fiber content of xylitol-sweetened cookies**

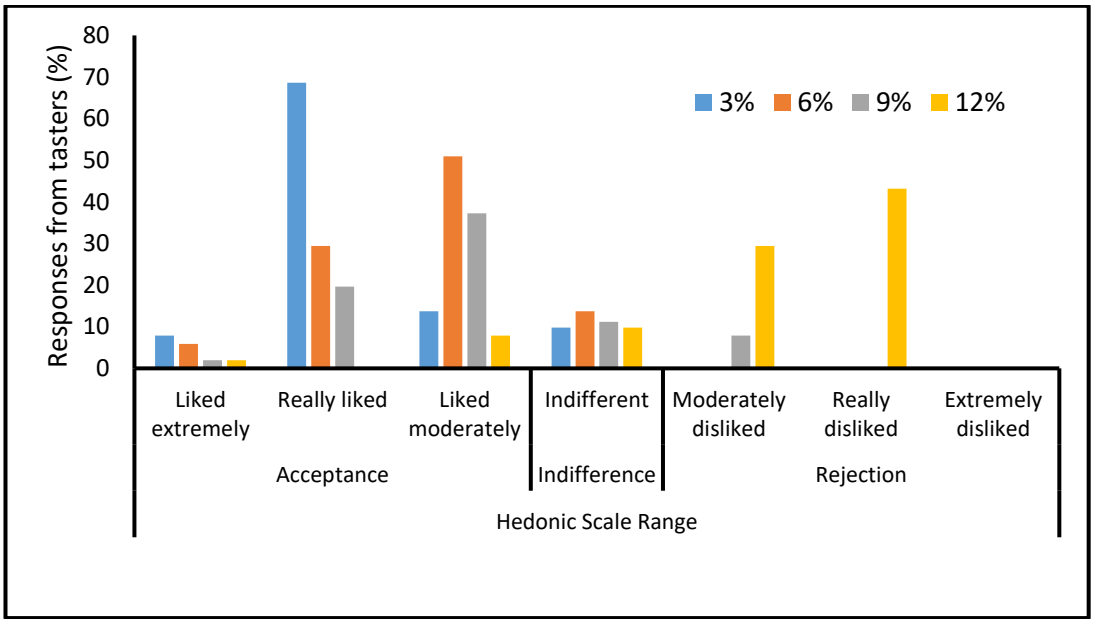


**Fig. 2. Effect of adding powdered passion fruit albedo on the distribution of panelists' responses in the ranges of the Hedonic Scale, during the sensory analysis of cookies sweetened with xylitol**

### 3.2 Sensory Quality Attributes

The cookies had a slightly brown color, characteristic of cookies with wheat flour, as no coloring was added. The flavor was predominant in the cookies made with wheat flour, however, with a slight passion fruit flavor. In cookies, flavorings are usually also added to the filling; in this case, the flavoring was added only to the dough, and was lost during cooking. The cookies with the lowest addition of passion fruit powder albedo (3%) had a softness closer to the texture of the control cookie. High amounts (6% to 12%) negatively influenced texture and acceptability scores.

The sensory analysis data show that the addition of powdered passion fruit albedo significantly influenced the tasters' preference. The proportions of 3, 6, 9 and 12% were preferred by 62.74%, 29.41%, 5.88% and 2.29% of tasters, respectively. Comparing the mean results (*n=51*) of acceptability (data from the Structured Hedonic Scale), the cookies added with 3% of powdered passion fruit albedo was the most accepted. Although the cookies with the lowest additions (3% and 6%) also received responses in the range of acceptance of the scale (I liked it extremely to I liked it moderately), the cookies with 3% was the one that stood out, reaching the highest score (Fig. 2). The highest additions of powdered passion fruit albedo (9% and 12%), had a negative influence, diluting the sweetness and flavor of the passion fruit (essence of passion fruit added), and mainly, drastically increasing the hardness of the cookies. The more hard texture (Table 2) and the lower amounts of carbohydrates (Table 3) were noticed in the sensory analysis, as the tasters reported that they were hard and tasteless.

## 4. CONCLUSION

Powdered passion fruit albedo has good potential as a source of dietary fiber, as bioactive substances positively influenced sensory attributes and nutritional and functional value. Higher amounts (6% to 12%) negatively influenced texture and acceptability. The best amount of powdered passion fruit albedo was 3%, as it increased moisture, proteins, fiber, pectin and ash, reduced lipids, carbohydrates and calories, and presented better texture, achieved greater acceptability and was the most preferred. Thus, the cookie sweetened with xylitol and enriched with powdered passion fruit albedo in a proportion of 3% was recommended as an alternative for the production of functional food.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES


Ahmed, A. R., & Labavittch, J. M. (1977). A simplified method for accurate determination of cell wall uronic content. *J Food Biochem, 1*(4), 361-365.

Anjo, D. F. C. (2004). Functional foods in angiology and vascular surgery. *J Vasc Bras, 3*(2), 145-154.

Antarkar, S., Sharma, A., Bhargava, A., Gupta, H., Tomar, R., & Srivastava, S. (2019). Physico-chemical and nutritional evaluation of cookies with different levels of rosehip and hibiscus powder substitution. *Arch. Curr. Res. Int.*, *17*(3), 1-10. Available from https://journalacri.com/index.php/ACRI/article/view/365

ANVISA - National Health Surveillance Agency. (1978). CNNPA Resolution No. 12, July 1978. Retrieved October 9, 2009, from http://www.anvisa.gov.br

Anzaldúa, M. (1994). *Sensory evaluation of foods in theory and practice*. Espana: S.A.

AOAC - Association of Official Analytical Chemists. (1997). *Official methods of analysis of A.O.A.C. International* (16th ed.). Gaithersburg, MD: A.O.A.C. International.

Araújo, L. M. (2007). Production of functional foods formulated with xylitol from cupuaçu (*Theobroma grandiflorum*) and passion fruit (*Passiflora edulis* f. *flavicarpa*). (Doctoral thesis). Universidade Federal do Amazonas.

Bar, A. (1991). Xylitol. In L. O'Brien Nabors & R. C. Gelardi (Eds.), *Alternative sweeteners* (2nd ed., pp. 349-379). New York: Marcel Dekker Inc.

Bello, F. A., Akpan, E.-O. E., & Ntukidem, V. E. (2020). Development and quality characteristics of cookies from sprouted sorghum, pigeon pea and orange fleshed sweet potato flour blends. *Eur. J. Nutr. Food. Saf.*, *12*(2), 11-12. Available from https://journalejnfs.com/index.php/EJNFS/article/view/371

Brazil. Ministry of Health. (1978). Approves special technical standards of the state of São Paulo, related to food and beverages. *Resolution CNNPA No. 12*, Official Gazette of July 24, 1978, Section 1, p. 1.

Calixto, F. S. (1993). Apple dietary fiber: Towards new types of high-quality fibers. *Alimentaria, 4*(1), 57-61.

Cordová, K. V., Gama, T. T. B., Winter, G. K. N., & Freitas, R. J. S. (2005). Physicochemical characteristics of yellow passion fruit (*Passiflora edulis flavicarpa Degener*) peel obtained by drying. *B Ceppa, 23*(2), 221-230.

Faustin, A. M. H., Barbato, E. V., Dias, E. L., Machado, Q. R. G., Almeida, J. V., & Ayla, L. A. (2007). Preparation of savory cookies with added dehydrated tomato (*Lycopenicum esculentun* (L) H. KARST) and onion (*Allium cepal*). In V week of food technology, May 2007. Paraná: Paraná University of Technology.

Ferrari, R. A., & Ayub, R. A. (2004). Characterization of byproducts from passion fruit industrialization: Use of seeds. *Rev Bras Frutic, 26*(1), 101-102.

García-Baños, J. L., Villamiel, M., Olano, A., & Rada-Mendoza, M. (2004). Study of non-enzymatic browning in cookies, crackers and breakfast cereals by determination of maltulose and furosine. *J Cereal Sci, 39*(2), 167-173.

Guilherme, F. F. P., & Jokl, L. (2005). Use of better protein quality cornmeal in mixed flours for the production of biscuits. *Cienc Tecnol Aliment, 25*(1), 63-71.

Krüger, C. C. H., Comassetto, M. C. G., Cândido, L. M. B., Baldini, V. L. S., Santucci, M. C., & Sgarbieri, V. C. (2003). "Cookie" and "snack" type biscuits enriched, respectively, with casein obtained by enzymatic coagulation and sodium caseinate. *Ciênc Tecnol Alim, 23*(1), 81-86.

Machado, S. S., Cardoso, R. L., Matsuura, F. C. A. U., & Folegatti, M. I. S. (2003). Physical and physicochemical characterization of yellow passion fruit from the region of Jaguaquara - Bahia. *Magistra, 15*(2), 229-233.

Maciel, L. M. B., Pontes, D. F., & Rodrigues, M. C. P. (2008). Effect of the addition of flaxseed meal of biscuits type in processing cracker. *Alim Nutr, 19*(4), 385-393.

Mussato, S. I., & Roberto, C. I. (2008). Xylitol: Sweetener with beneficial effects on human health. *Rev Bras Ciênc Farm, 38*(4), 385-393.

Pereira, C. A., Beux, S., Santos, M. S., Busato, B. S., Kobelnick, M., & Barama, A. N. (2005). Use of flour obtained from potato waste in the preparation of cookies. *Publ UEPG Exact Soil Sci Agr Sci Eng, 11*(1), 19-26.

Silva, M. R. (1997). *Chemical and nutritional characterization of jatobá flour (Hymenaea stigonocarpa Mart.): development and optimization of products through affective sensory tests* (Doctoral thesis). Faculty of Food Engineering, State University of Campinas.

Silva, M. R., Silva, M. P. A., & Chang, Y. K. (1998). Use of Jatobá flour (*Hymenaea stigonocarpa* Mart.) in the preparation of cookie-type biscuits and evaluation of acceptance by univariate and multivariate affective sensory tests. *Ciênc Tecnol Alim, 18*(1), 25-34.

Southgate, D. T. A. (1991). *Determination of food carbohydrates* (2nd ed.). Elsevier Applied Science.

Souza, M. L. (2001). Processing of Brazil nut cookies. *B Ceppa, 19*(2), 381-390.

Taco - Brazilian Food Composition Table. (2006). *2nd ed.* Campinas, SP: NEPA-UNICAMP.

Tonato, C. (2007). Food health. *Ainsten. Educ. contin. health, 5*(3), 97-99.

Valença, R. D. S. F., Santana, M. F. S., & Freitas, M. M. (2008). Use of bacuri bark for the production of biscuits. VI Scientific Initiation Seminar of UFRA and XII Scientific Initiation Seminar of EMBRAPA Amazônia Oriental.

Vitti, P., Garcia, E. E. C., & Oliveira, L. M. (1988). *Cookie technology*. São Paulo: Government of the State of São Paulo; Campinas: Institute of Food Technology.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*https://www.sdiarticle5.com/review-history/127612*