

ORIGINAL ARTICLE

Muffins nutritionally enriched with taioba flour (*Xanthosoma sagittifolium*)

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Abstract

Non-conventional food plants (NCFP) are an alternative for the developing of food products given their improved nutritional quality. Aiming to enrich minerals, this study utilized taioba leaves (*Xanthosoma sagittifolium*) to produce flour and prepare muffins. NCFP is an alternative for developing food products with better nutritional quality as being source of nutrients, thus indicating the relevance of this research. This investigation aimed to produce flour and prepare nutritionally enriched muffins, in addition to verifying their chemical composition and sensory acceptability. Taioba leaves were dried in a solar dryer and then ground in a knife mill. Three muffin formulations were prepared: a standard formulation and two formulations with different concentrations of taioba flour. The muffins were prepared with wheat flour, taioba flour, milk, margarine, eggs, baking powder, brown sugar, and crystal sugar, with the respective proportions of ingredients defined through laboratory tests. Physicochemical, microbiological, and sensory analyses were performed. According to the results of the ash and moisture analyses, the moisture content of the flour was below the legal limit, which is a maximum of 15%. Thus, these products proved to have good physical and chemical stability. The ash content was relatively high, indicating that the flour has mineral content. The muffins with taioba flour had a softer texture than the standard sample, without the presence of microorganisms, and presented sensory acceptability higher than 7.5 for all attributes, in addition to an intention to buy above 80%.

Keywords: Color parameters; Total coliform counts; Thermotolerant coliform counts; Fungal and yeasts; Non-conventional food plants (NCFP); Sensory acceptability; Value addition.

Highlights

- Use of a Non-Conventional Food Plant for the nutritional enrichment of muffins: a new bakery product
- High sensory acceptability of muffins added with *Xanthosoma sagittifolium* flour
- Microbiological stability of food products after incorporation of flour into muffins



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1 Introduction

Brazil shelters a wide range of edible plants, which are often considered weeds but have high nutritional value, and yet are unknown to the population. These plants are known as Non-Conventional Food Plants (NCFP) and can be either spontaneous or cultivated, native or exotic plants that are not part of our daily menu (Ferreira et al., 2021a; Kelen et al., 2015).

Taioba (*Xanthosoma sagittifolium*) stands out within this large group of non-conventional plants, being traditionally cultivated in the interior of Brazilian states, such as Mato Grosso do Sul, whose leaves and stems contain calcium, phosphorus, iron, magnesium, and also vitamin C (Caxito et al., 2015). Araújo et al. (2019) reported significant levels of phenolic compounds, vitamin C, and chlorophyll, which, due to their ability to capture free radicals, can prevent cell damage or oxidation reactions, benefiting human health by strengthening the immune system. The lack of information (Kinupp & Lorenzi, 2014) highlights the need for scientific studies to publicize their potential and encourage consumption given their nutritional properties, especially due to their short shelf life and rapid deterioration.

Alternative routes must be established based on the lack of consumption of these foods; therefore, products or preparations must be developed to meet the nutrient needs of these individuals by adding foods rich in vitamins and minerals, such as vegetables (Ferreira et al., 2020; Kinupp & Barros, 2008).

In this sense, applying NCFP in food products is an excellent alternative to increase shelf life, especially for bakery products, such as muffins. Studies using alternative sources for enriching muffins have reported great technological potential, mainly due to the high sensory acceptance of the products and the availability of nutrients (Torres et al., 2022; Ferreira et al., 2021b).

Given the above, this study aims to use taioba (*Xanthosoma sagittifolium*) in the preparation and nutritional enrichment of muffins and to assess its characterization through physical, chemical, microbiological, and sensory analyses.

2 Material and methods

2.1 Plant material

Taioba leaves (*Xanthosoma sagittifolium*) were collected in the municipality of Coxim, in the state of Mato Grosso do Sul, Brazil (latitude 18° 48' 65.93"S and longitude 54° 76' 36.77"W). The materials were stored in thermal boxes, transported to the Fruit and Vegetable Laboratory of the Federal Institute of Mato Grosso do Sul, cleaned with running water, and dried using paper towels. The materials were also sanitized by immersion in Sodium Dichloroisocyanurate Dihydrate (Sumaveg, from Diversey Lever®) at 200 ppm of active chlorine for 15 min, dehydrated in a solar dryer for 48 hours at an average local temperature of 30 degrees Celsius (Figure 1), and crushed in a knife mill (Retsch®). The other ingredients used in the formulations were purchased from local stores.



Figure 1. Solar drying of Taioba (*Xanthosoma sagittifolium*) leaves.

2.2 Muffins formulation

Three muffin formulations were prepared: a standard formulation (P) and two formulations with different concentrations of taioba flour. F1 was added with 10% taioba flour, and F2 was added with 20% taioba flour. The muffins were prepared with wheat flour, taro flour, milk, margarine, eggs, baking powder, brown sugar, and crystal sugar. Table 1 shows the proportions of the ingredients adapted from Ferreira et al. (2021b).

Table 1. Ingredients and formulation of muffins added with taioba flour.

Ingredients	P	F1	F2
Wheat flour (g)	155	139.5	124
Cocoa (g)	30	30	30
Crystal sugar (g)	114	114	114
Egg (g)	100	100	100
Oil (mL)	60	60	60
Chemical yeast (g)	8	8	8
Milk (mL)	150	150	150
Taioba flour (g)	--	15.5	31

P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour.

2.3 Physical and chemical characterization

The diameter and thickness of 50 muffin units expressed in millimeters were determined using a digital caliper (*Digimess*), according to the procedures described in the AACC method 10-50D (American Association of Cereal Chemists, 1995), while mass was determined using a digital scale.

The taioba flour and the formulation of the muffins were characterized in terms of moisture content through the gravimetric method at 70 °C until constant weight (Association of Official Analytical Chemists, 1995). The mineral content was calculated by burning the excess sugar on a hot plate, followed by incineration in a muffle furnace (CE-800/S4 - CIENLAB®) at 550 °C, until the light mineral and constant weight (Association of Official Analytical Chemists, 1992). Instrumental color was assessed for taioba flour and muffins following the instrumental method at five points of each sample, using a Konica Minolta colorimeter (Model CR-400/Cr-410®), with a CIE system $L^*a^*b^*$. The following parameters were assessed: luminosity (L^*), red-green (a^*), blue-yellow (b^*) chromaticity, hue angle (h), and chroma (C^*); the latter were calculated by Equations 1 and 2, respectively (McGuire, 1992).

$$h = \tan^{-1} \left(\frac{a^*}{b^*} \right) \quad (1)$$

$$C^* = \sqrt{(a^{*2} + b^{*2})} \quad (2)$$

Texture analysis (hardness) was performed on a texturometer (TA.HDi, Stable Micro Systems) by compression force test, with a flat-bottomed stainless steel cylindrical probe (36 mm in diameter), at a distance of 10 cm and pre-test, test, and post-test speeds of 5, 2 and 2 mm.s⁻¹, respectively.

2.4 Microbiological characterization

The samples were assessed to determine total and heat-resistant coliforms, as well as fungal and yeast counts according to the methodology of the American Public Health Association (APHA) (American Public Health Association, 2001). The total and heat-resistant coliform counts were performed following the most probable number (MPN) method, while fungal and yeast counts were performed by the colony-forming unit (CFU.g⁻¹) method. Microbiological analyses were performed based on resolution RDC N°. 12 of January 2,

2001, by ANVISA (National Health Surveillance Agency), which approves the technical regulation on microbiological standards for food (Brasil, 2001).

2.5 Sensory analysis

The project was approved by the Research Ethics Committee of the Federal Institute of Mato Grosso do Sul, under protocol number 1228, and all participants have signed free and informed the Consent Form. The sensory analysis was performed at the Federal Institute of Mato Grosso do Sul, Coxim campus. Acceptance tests were performed with 60 untrained judges, who received three samples coded with three digits.

The evaluation form consisted of a sample acceptability test following a 9-point hedonic scale, ranging from 1 (disliked it very much) to 9 (liked it very much). The following attributes were assessed: appearance, color, aroma, texture, flavor, and overall quality. Each judge also indicated their intention to buy for the samples evaluated (Dutcosky, 2011), the frequency of consumption of muffins, and their favorite sample. Samples that received scores greater than or equal to 6 (slightly liked) were considered accepted.

2.6 Statistical analysis

The physical and chemical analyses were performed in triplicate, and the results were expressed as mean and standard deviation. The results of the sensory analysis were expressed as mean, and the Analysis of Variance (ANOVA) was performed. All results were calculated on Excel® 2016 software.

3 Results and discussion

Tables 2 and 3 show the results of the analysis of moisture, ash, and instrumental color of the taioba flour (*Xanthosoma sagittifolium*) obtained by solar drying.

The moisture content of the flour was below the legal limit, which is a maximum of 15%. Thus, such products have good physical and chemical stability provided that they are stored properly in hermetically sealed packaging (Munhoz et al., 2009; Brasil, 2005). Compared with our results, Silva et al. (2009) reported a slightly higher moisture content (10.49%) for taioba flour. As the authors used convective drying, this difference is likely to be linked to the drying conditions. The taioba flour showed a high ash content, indicating that it is a mineral-rich product that has the potential to enrich bakery products. Such result is close to that reported by Silva et al. (2009), 12.32% ash. Using unconventional foods with nutritional potential is the simplest way to increase the nutritional value of the diet of vulnerable populations. Since many vegetables, such as taioba, are rich in minerals, meeting many of the daily needs, it is important to encourage the consumption of regional vegetables with nutritional potential, especially in deprived regions of the country (Silva et al., 2009). The coloration of the taro flour tended to be dark green, according to the values of L^* and a^* , given the green coloration of the in natura leaves of the PANC.

Table 2. Moisture content, ash, and instrumental color of taioba (*Xanthosoma sagittifolium*) flour.

Analysis	Mean $\pm$ standard deviation
Moisture	7.79 $\pm$ 0.78
Ash	11.46 $\pm$ 0.09
Color parameters	
L^*	51.79 $\pm$ 3.43
a^*	-2.10 $\pm$ 0.13
b^*	21.70 $\pm$ 0.29
C^*	21.67 $\pm$ 0.16
$^{\circ}h$	95.87 $\pm$ 0.97

Table 3. Average values of moisture, ash, and instrumental color of muffins nutritionally enriched with taioba flour (*Xanthosoma sagittifolium*).

Analysis (g 100 g ⁻¹)	P	F1	F2
Moisture	29.19 ± 0.06 ^b	30.79 ± 0.12 ^a	27.35 ± 0.14 ^c
Ash	1.44 ± 0.03 ^c	1.85 ± 0.03 ^b	2.34 ± 0.01 ^a
<i>Color parameters</i>			
L*	27.59 ± 1.74 ^a	20.88 ± 1.24 ^b	20.85 ± 2.04 ^b
a*	11.23 ± 0.47 ^a	7.70 ± 0.29 ^b	6.27 ± 0.60 ^c
b*	17.56 ± 0.52 ^a	15.02 ± 0.61 ^b	13.85 ± 0.98 ^c
C*	20.84 ± 0.70 ^a	16.87 ± 0.67 ^b	15.18 ± 1.16 ^c
°h	57.41 ± 0.67 ^c	61.64 ± 1.76 ^b	65.65 ± 0.58 ^a

Values expressed as mean ± standard deviation. P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour. Equal letters in the same line indicate that the samples do not differ from each other ($p > 0.05$).

Table 3 shows the moisture, ash, and instrumental color values for the muffins. The moisture content varied statistically among all formulations ($p \leq 0.05$). The formulations with 10% and 20% taioba flour had the highest and lowest moisture content, respectively. The moisture contents were higher than those reported by Cecchi (2003) for muffins prepared with soursop pulp residue. Such variation may be associated with the difference in the muffin formulation. The ash content differed statistically among all formulations ($p \leq 0.05$) and was higher as the taioba flour increased, indicating the higher mineral content in formulation F2. A similar behavior was observed in cupcakes with baru (Marcelino et al., 2018), in which the sample with baru flour showed an increase in ash content. Ferreira et al. (2021a) found values of 2.78 g 100 g⁻¹ of ash, close to that found herein when characterizing lactose- and gluten-free muffins added with spinach and.

The color analysis showed that all formulations differed statistically in the parameters assessed ($p \leq 0.05$). The samples tended to black due to the presence of taioba flour and cocoa. The samples with taioba flour tended to be green, with a higher tendency toward the color in the sample added with 20%, according to the parameter a*. Table 4 presents the results of hardness (texture), mass, diameter, and thickness for muffins enriched with taioba flour (*Xanthosoma sagittifolium*) flour. The hardness of the formulations with taioba flour showed similar values ($p > 0.05$) and lower than the standard ($p \leq 0.05$). The use of taioba flour made the muffins softer.

Table 4. Hardness, mass, diameter, and thickness parameters of muffins nutritionally enriched with taioba (*Xanthosoma sagittifolium*).

Parameters ¹	P	F1	F2
Hardness (N)	8.25 ± 0.28 ^a	4.99 ± 0.02 ^b	5.22 ± 0.64 ^b
Mass (g)	45.42 ± 3.77 ^a	45.35 ± 1.57 ^a	44.61 ± 2.51 ^a
Diameter (cm)	6.50 ± 0.21 ^a	6.43 ± 0.17 ^a	6.25 ± 0.16 ^a
Thickness (cm)	5.24 ± 0.22 ^a	5.42 ± 0.21 ^a	5.29 ± 0.15 ^a

¹Values expressed as mean ± standard deviation. P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour. Equal letters in the same line indicate that the samples do not differ from each other ($p > 0.05$).

The muffins that were nutritionally enriched with taioba flour (*Xanthosoma sagittifolium*) (Figure 2, according to the levels of taioba insertion. P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour.) were subjected to the same baking time and temperature treatment. The obtained parameters of mass, diameter, and thickness showed no statistical difference ($p > 0.05$). Microbiological stability tests also ensured food safety for the muffins, since there were no total coliform counts or thermotolerant coliforms for the different formulations of muffins added with taioba. No fungal or yeast counts were identified either, thus guaranteeing compliance with the regulations (Brasil, 2001).

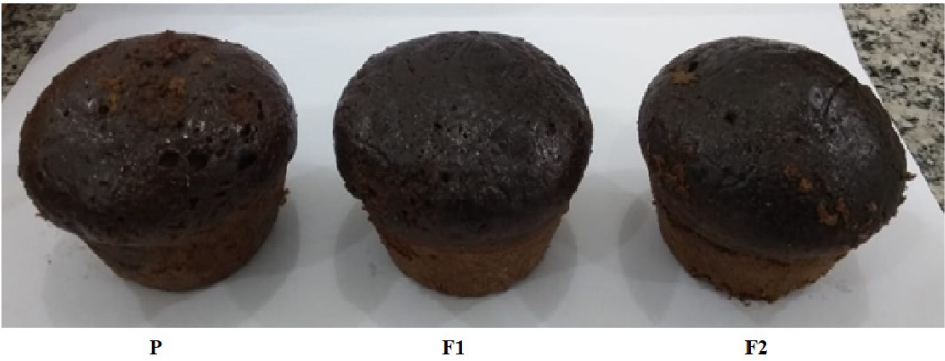


Figure 2. Formulations developed according to the levels of taioba insertion. P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour.

Table 5 shows the averages of the attributes assessed. The samples showed no statistical difference for the attributes assessed ($p > 0.05$). The averages reached ranged between 7.5 (I liked it regularly) and 8.2 (I liked it very much). The samples with 10% and 20% taioba flour reached the highest averages for the softness attribute.

Table 5. Averages of sensory attributes of muffins nutritionally enriched with taioba (*Xanthosoma sagittifolium*).

Attributes ¹	P	F1	F2
Appearance	7.8 ± 1.0 ^a	7.9 ± 0.8 ^a	8.0 ± 0.8 ^a
Color	7.9 ± 1.0 ^a	7.9 ± 0.6 ^a	8.0 ± 0.8 ^a
Aroma	7.8 ± 1.0 ^a	7.5 ± 0.9 ^a	7.8 ± 1.0 ^a
Softness	7.9 ± 0.9 ^a	8.2 ± 0.6 ^a	8.1 ± 0.7 ^a
Flavor	7.8 ± 1.0 ^a	7.9 ± 0.7 ^a	7.8 ± 1.1 ^a
Sweetness	7.7 ± 1.0 ^a	7.7 ± 0.8 ^a	7.5 ± 1.1 ^a
Overall quality	8.0 ± 0.7 ^a	8.0 ± 0.6 ^a	7.8 ± 0.8 ^a

¹Values expressed as mean ± standard deviation. P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour. Equal letters in the same line indicate that the samples do not differ from each other ($p > 0.05$).

The preference analysis (Figure 3) showed that the judges preferred the standard formulations and (F2) that added with 20% taioba. In turn, the formulation added with 10% taioba (F1) was the least preferred by the judges.

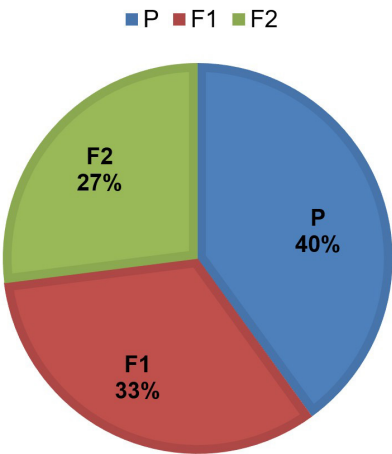


Figure 3. Sample preference for muffins nutritionally enriched with taioba (*Xanthosoma sagittifolium*). P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour.

The consumption of muffins nutritionally enriched with taioba (*Xanthosoma sagittifolium*) (Figure 4) reached the following percentages and frequencies: 6% every day – indicating a low consumption by the judges –; 23% three times a week; 36% once a week; 11% once a month; 16% rarely, and 8% never.

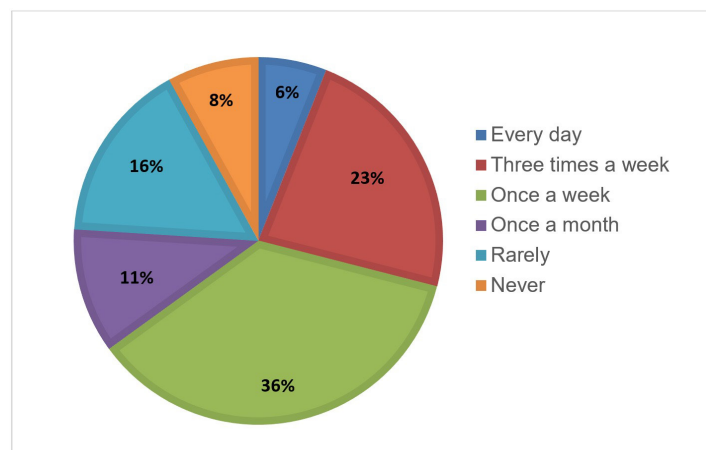


Figure 4. Frequency of consumption of muffins nutritionally enriched with taioba (*Xanthosoma sagittifolium*). P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour.

In terms of intention to buy (Figure 5), 47% of the judges suggested that they would certainly buy the product, while 42% stated they would probably buy it, 10% would perhaps buy it, and 1% would certainly not buy it, thus indicating the potential for commercialization of the.

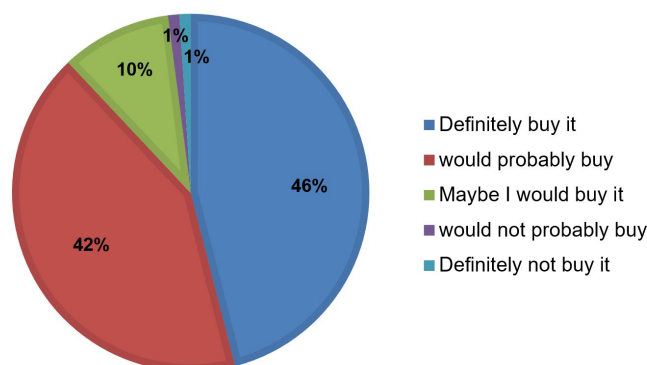


Figure 5. Intention to buy muffins nutritionally enriched with taioba (*Xanthosoma sagittifolium*). P: Standard; F1: formulation with 10% taioba flour; F2: formulation with 20% taioba flour.

4 Conclusions

The use of taioba flour proved to be viable for bakery products, such as muffins. The moisture content meets the current legislation and indicates a high mineral content. The muffins made with taioba flour showed a higher content of minerals and a softer texture. Sensory acceptance was excellent and the intention to buy was high.

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References

- American Association of Cereal Chemists – AACC. (1995). *Approved methods of the AACC* (9th ed., 1200 p.). St. Paul: AACC.
- American Public Health Association – APHA. (2001). *Compendium of methods for the microbiological examination of foods* (4th ed.). Washington: APHA.
- Araújo, S. S., Araújo, P. S., Giunco, A. J., Silva, S. M., & Argandoña, E. J. S. (2019). Bromatology, food chemistry and antioxidant activity of *Xanthosoma sagittifolium* (L.) Schott. *Emirates Journal of Food and Agriculture*, 31(3), 188-195. <http://doi.org/10.9755/ejfa.2019.v31.i3.1924>
- Association of Official Analytical Chemists – AOAC. (1992). *Official methods of analysis of the association of official analytical chemistry* (11th ed.). Arlington: AOAC.
- Association of Official Analytical Chemists – AOAC. (1995). *Official methods of analysis of the association of official analytical chemistry* (16th ed.). Arlington: AOAC.
- Brasil. Ministério da Saúde. (2001). Resolução – RDC nº 12, de 2 de janeiro de 2001. Aprova o regulamento técnico sobre padrões microbiológicos para alimentos. *Diário Oficial [da] República Federativa do Brasil*, Brasília.
- Brasil. Ministério da Saúde. Agência Nacional de Vigilância Sanitária – ANVISA. (2005). *Métodos físico-químicos para análise de alimentos* (1018 p.). Brasília: Ministério da Saúde.
- Cecchi, H. M. (2003). *Fundamentos teóricos e práticos em análises de alimentos* (2. ed.). Campinas: Editora da Unicamp. <http://doi.org/10.7476/9788526814721>.
- Caxito, M. L. C., Correia, R. R., Gomes, A. C., Justo, G., Coelho, M. G., Sakuragui, C. M., Kuster, R. M., & Sabino, K. C. (2015). *In vitro* antileukemic activity of *Xanthosoma sagittifolium* (Taioaba) leaf extract. *Evidence-Based Complementary and Alternative Medicine*, 2015, 384267. PMID:26180533. <http://doi.org/10.1155/2015/384267>
- Dutcosky, S. D. (2011). *Análise sensorial de alimentos*. Curitiba: Champagnat.
- Ferreira, T. H. B., Reis, A. P. L., Souza, L. S., Rodrigues, H. O., Guimarães, R. C. A., & Munhoz, C. L. (2021a). Physical, chemical, sensory and mineral characterization of salty muffins enriched with *Tetragonia tetragonoides*. *Brazilian Journal of Food Technology*, 24, 1-7. <http://doi.org/10.1590/1981-6723.18920>
- Ferreira, T. H. B., Cunha, A. L. T., Guimarães, R. C. A., Ito, F. M., & Munhoz, C. L. (2021b). Elaboração de muffins adicionados de espinafre e isentos de lactose e glúten. *Journal of Biotechnology and Biodiversity*, 9(2), 170-177. <http://doi.org/10.20873/jbb.uft.cemaf.v9n2.ferreira>
- Ferreira, T. H. B., Silva, S. R., Munhoz, C. L., & Argandona, E. J. S. (2020). Elaboration of biscuits type cookies with pre-treated baru (*Dipteryx alata* Vog.) pulp flour. *Journal of Food Measurement and Characterization*, 14(6), 1-7. <http://doi.org/10.1007/s11694-020-00557-3>
- Kelen, M. E. B., Nouhuys, I. S. V., Kehl, L. C., Brack, P., & Silva, D. B. (2015). *Plantas alimentícias não convencionais (PANC's): Hortaliças espontâneas e nativas* (1. ed.). Porto Alegre: UFRGS.
- Kinupp, V. F., & Barros, I. B. I. D. (2008). Teores de proteína e minerais de espécies nativas, potenciais hortaliças e frutas. *Food Science and Technology*, 28(4), 846-857. <http://doi.org/10.1590/S0101-20612008000400013>
- Kinupp, V. F., & Lorenzi, H. (2014). *Plantas alimentícias não convencionais (PANC) no Brasil: Guia de identificação, aspectos nutricionais e receitas ilustradas* (pp. 118-121). São Paulo: Instituto Platarum de Estudos da Flora.
- Marcelino, G., Coleta, I. T., Candido, C. J., & Santos, E. F. (2018). Caracterização e análise sensorial de cupcakes elaborados com diferentes concentrações de farinha de casca e polpa de baru (*Dipteryx alata* Vog.). *Multitemas*, 23, 265-281. <http://doi.org/10.20435/multi.v23i54.1753>
- McGuire, R. G. (1992). Reporting of objective color measurements. *HortScience*, 27(12), 1254-1255. <http://doi.org/10.21273/HORTSCI.27.12.1254>
- Munhoz, C. L., Sanjinez-Argandona, E. J., & Soares Junior, M. S. (2009). Caracterização física e química de farinhas de goiaba (*Psidium guajava* L.), cultivar Pedro Sato. *Higiene Alimentar*, 23, 146-149.
- Silva, M. R., Rocha, C. R., Silva, T. M., Silva, M. C., Paes, M. C. D., & Pinto, N. A. V. D. (2009). Caracterização química e antinutricional de farinhas de hortaliças não-convencionais. *Tecnologia & Ciência Agropecuária*, 7, 51-57.
- Torres, K. S., Sampaio, R. F., Ferreira, T. H. B., & Argandoña, E. J. S. (2022). Development of cookie enriched with silkworm pupae (*Bombyx mori*). *Journal of Food Measurement and Characterization*, 16(2), 1540-1548. <http://doi.org/10.1007/s11694-021-01208-x>

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