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TRABALHO DE CONCLUSÃO DE CURSO

URUTAÍ, GOIÁS
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Trabalho de Conclusão de Curso apresentado a Banca Avaliadora e à Coordenação do Curso de Bacharelado em Nutrição do Instituto Federal Goiano – Campus Urutaí como exigência para conclusão do curso.
Orientador: Prof. Dr. Luiz Fernando de Camargos

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PHYSICAL AND CHEMICAL CHARACTERIZATION OF THE PEEL, SEED AND PULP OF BANHA-DE-GALINHA (Swartzia parvipetala), FRUIT FROM THE CERRADO

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ATA DE APRESENTAÇÃO DE TRABALHO DE CONCLUSÃO DE CURSO

No dia 11 do mês de MARÇO de 2025, às horas e minutos, reuniu-se a banca examinadora composta pelos docentes Luiz Fernando de Camargos, Ingrid Garcia de Oliveira, Herbert Junior Dias,

para examinar o Trabalho de Curso (TC) intitulado Proximate composition, functional properties, and technological capabilities of 3 fractions of banana-de-zalinha (Swartzia grevipetala), a predominant fruit of the Cerrado

do(a) acadêmico(a) Pâmella Barros Dias, Matrícula nº 2021101203940115 do curso de Ciência e Tecnologia de Alimentos do IF Goiano – campus Urutaí. Após a apresentação oral do TC, houve arguição do candidato pelos membros da banca examinadora. Após tal etapa, a banca examinadora decidiu pela Aprovação do(a) acadêmico(a). Ao final da sessão pública de defesa foi lavrada a presente ata, que segue datada e assinada pelos examinadores. Após análise, foram dadas as seguintes notas:

Professores	Nota
1. Luiz Fernando de Camargos	9,17
2. Ingrid Garcia de Oliveira	9,15
3. Herbert J. Dias	9,10
Média final:	9,14

Urutaí, 11 de MARÇO de 2025.

Orientador(a)

SUMÁRIO

1. ARTIGO

PHYSICAL AND CHEMICAL CHARACTERIZATION OF THE PEEL, SEED AND PULP OF BANHA-DE-GALINHA (*Swartzia parvipetala*), FRUIT FROM THE CERRADO

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ABSTRACT:

Background of the research. The study focuses on *Swartzia parvipetala*, commonly known as Banha-de-Galinha, a native fruit of the Brazilian Cerrado. This species remains scientifically underexplored with no consolidated information. Existing research highlights the bioactive and therapeutic properties of other species from the *Swartzia spp.*, but there is a gap in knowledge regarding the composition and applicability of this particular fruit. This study aims to fill that gap by providing information on the proximate composition, technological characteristics, phytochemical properties, and antibacterial capabilities of the fruit's peel, seed, and pulp fractions.

Experimental approach. This work is a descriptive study based on widely used experimental methodologies conducted with three fractions of the Banha-de-Galinha fruit. Samples were collected, frozen, dehydrated, ground, and subjected to various analyses to evaluate their chemical composition, technological properties, presence of

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bioactive compounds, and antibacterial activity. Statistical methods, such as ANOVA and Tukey's post hoc test, were applied to validate the results.
Results and conclusions. The study revealed that the peel, seed, and pulp fractions of *Swartzia parvipetala* have distinct characteristics in their chemical composition and technological possibilities. Analyses indicated high fiber content, significant moisture, and water absorption capacity. The presence of bioactive compounds, such as saponins and tannins, was identified, although none of the fractions demonstrated antibacterial activity under the evaluated conditions. These results reinforce the fruit's nutritional and functional potential, as well as its applicability in various sectors, such as food and industry. The study also highlights the need for additional research to further explore and optimize the fruit's use in specific formulations.
Scientific novelty and contribution. This research provides a novel and detailed analysis of the composition and properties of Banha-de-Galinha, significantly contributing to the scientific knowledge of native Cerrado species. In addition to emphasizing the importance of this fruit, the study promotes its sustainable use and valorization as a potential nutritional, therapeutic, and industrial resource.

Keywords: phytochemicals; analysis; compounds; antibacterial.

INTRODUCTION

The Cerrado is located in central Brazil, covering 12 of the country’s 27 federal units and ranking as its second-largest biome (*1*). Cerrado plants are adapted to diverse environmental conditions, including prolonged drought periods, heavy rainfall, nutrient-poor soils, frequent wildfires, and high solar radiation incidence (*2*). The use of Cerrado fruits has great potential in Brazil’s agricultural industry, as processing and utilizing these fruits not only increase their economic and nutritional value but also enhance their distinctive characteristics such as aroma, flavor, and color (*3*).

Compounds like fibers, vitamins, minerals, and antioxidants play a key role in overall bodily functions, particularly for human health. Some bioactive compounds give fruits functional properties, offering protective and preventive potential against diseases caused by oxidative stress. These diseases arise from an imbalance between oxidants and antioxidant compounds, leading to an excessive amount of free radicals and contributing to chronic conditions such as non-communicable diseases (NCDs) and câncer (*4*).

Native species can be consumed fresh or used in processed food production, attracting interest from sectors focused on innovation. However, many of these species remain unknown to people outside the Cerrado and also to those living in the biome (*5*). Despite their rich nutritional and functional value, several fruits from the Brazilian Cerrado remain understudied (*6*), including Swartzia parvipetala, commonly known as Banha-de-Galinha and highlighted by people who have it on their property as a tree whose leaves cows often eat. The fruit's nutritional potential, low cost, and high resilience make it a viable dietary supplement in therapeutic approaches to various diseases. However, not all of its effects on the human body have been explored. Investigating the fruit's physical characteristics, macronutrient and micronutrient content, and antioxidant compounds will provide an ideal basis for recommending its consumption and potential nutritional applications (*4*).

S. parvipetala belongs to the *Swartzia* spp. within the Fabaceae family and the Papilionoideae subfamily. This genus is known for producing various classes of relevant phytochemical compounds such as saponins, flavonoids, and diterpenoids. These compounds possess notable biological properties, including fungicidal, antimicrobial, larvicidal, molluscicidal, and antimalarial activities. Most species in this genus are trees ranging from 2 to 20 meters in height, though some are shrubs. Additionally, the genus is known for its high-quality wood, medicinal applications, and toxicity observed in some species (*7*).

Given the lack of published research on the centesimal composition, microbiological potential, phytochemical compounds and technological potential of Cerrado fruits, particularly *S. parvipetala*, the objective of this study is to perform the physical-chemical characterization of the peel, seed and pulp fractions of Lard.

MATERIALS AND METHODS

Study Characterization

This is a descriptive study involving experimental procedures of three fractions (peel, seed, and pulp) of *S. parvipetala* (Fig. 1 and 2). The fruit for the experiment was collected in October 2023 in the Cerrado region, native to Fazenda Vale Encantado, located 12 km from the BR-153 highway intersection in Morrinhos, Goiás, Brazil. After collection, the three studied samples were separated, placed in sealed packaging, and stored in a freezer at -20°C at the Plant Biotechnology Laboratory of the Federal Institute of Education, Science, and Technology of Goiás – Urutaí Campus until analyses began.

The species was identified by Vidal de Freitas Mansano, principal researcher at the Botanical Research Institute of Rio de Janeiro. The voucher specimen was deposited in the herbarium of the Federal Institute of Education, Science, and Technology of Goiás – Urutaí Campus under collection number 1 by the corresponding author, fall number 866, area number 2.08.00.00-2. Analyses and tests were conducted in triplicate, with data subjected to one-way ANOVA statistical analysis followed by Tukey's post-hoc test. Statistically significant differences were considered for values of $p < 0.05$. Statistical analyses were performed using GraphPad Prism 9.5.0® software.

Preparation of Dried Plant Material

The samples were thawed and dried in an oven at 50–55°C with forced air circulation until reaching a constant weight. They were then ground using a knife mill (Willey-type) from the Fortinox brand.

Preparation of the Hydroalcoholic Extract

The extract was obtained through exhaustive maceration over three consecutive weeks at a ratio of 100 g of dried plant material per 1 L of 80% ethanol (v/v). The filtrate was concentrated using a rotary evaporator at 50–55°C and stored as an extract in Falcon tubes, frozen at -20°C (*8 adapted*).

Proximate Composition

The proximate composition analysis was performed using samples of dried plant material. The determination of moisture content on a dry basis and ash content followed Association of Official Analytical Chemistry methods (*9*). For the determination of protein percentage, the Kjeldahl method was used (*9*). For the determination of lipid percentage, the Bligh & Dyer method was used (*10*). The determination of carbohydrate percentage was calculated by difference, based on the results of the other analyses. For fiber analysis, an adapted method was used (*11 adapted*). The total energy value (TEV) was calculated using Atwater conversion factors: 4 kcal/g for proteins and carbohydrates, and 9 kcal/g for lipids.

Technological possibilities

In the technological possibilites, dry plant material samples were used. The characterization of water absorptive capacity [WAC], oil absorptive capacity [OAC], milk absorptive capacity [MAC], water solubilization capacity [WSC], and gelation was carried out. The gelation was determined using samples with concentrations ranging from 2% to 20% (weight/volume), assessing the size of the formed gel (*12*). The WSC was determined according to Equation 1 below, which establishes the relationship between the evaporation residue and the initial weight of the flour. The WAC, OAC, and MAC were determined according to Equation 2. Gelation was determined using samples with concentrations ranging from 2% to 20% (weight/volume) (*13*).

Equation 1. Equation for determining the water solubilization capacity.

$$WSC = \frac{Evaporation\ residue\ (g)}{Sample\ weight\ (g)} \times 100 = \%$$

Where WSC is the water solubilization capacity, expressed as a percentage, resulting from the division of the evaporation residue by the initial sample weight, multiplied by 100.

Equation 2. Equation for determining water, milk, and oil absorption.

$$AC: \frac{Density\ \times\ Amount\ absorbed\ by\ the\ sample\ (ml)}{Sample\ weight\ (g)} = g/g$$

Where AC is the absorption capacity to be analyzed (water, oil, or milk), the density refers to the liquid used, with values of oil (0.921), milk (1.032), and water (1) applied in this study, divided by the sample weight. The result is expressed in g/g.

Phytochemicals

In the phytochemical analysis, dry plant material samples and the hydroalcoholic extract from the three fruit fractions were used. Saponin analyses were conducted with the dry plant material samples (*13-15*), tannins (*16*), alkaloids (*17*), anthraquinones (*18*) and coumarins (*19*). In the samples of the hydroalcoholic extract, saponin analyses were conducted (*13-15*), tannins (*16*), alkaloids (*17*), anthraquinones (*13*), flavonoids (*20*), coumarins (*16*) and polysaccharides (*16*). These tests are based on the visual observation of color changes or the formation of precipitates after the addition of specific reagents.

Antibacterial capacity

Five different doses of the compounds extracted from the *S. parvipetala* samples were evaluated in these assays. All of them were diluted in dimethyl sulfoxide [DMSO]. The concentrations used were based on the solubility limit in the solvent. For the evaluation of the antibacterial effect of the extracts from the three fractions of Banha-de-Galinha, reference bacterial species recommended for test control were used: *Salmonella typhimurium* - strain TA 98 Gram (-), Generously provided by Dr. Gisela A. Umbuzeiro, School of Technology, State University of Campinas (UNICAMP), Limeira, SP, Brazil. The TA98 strain has a mutation in the hisD gene (*hisD3052*) that codes for histidinol dehydrogenase, with a preferential reversion point consisting of eight repetitive GC residues. This strain detects mutagenic compounds that cause a frameshift in the DNA reading frame (*21*). The strains of *Staphylococcus aureus* (ATCC 25923) Gram (+), *Pseudomonas aeruginosa* (ATCC 27853) Gram (-) and *Escherichia coli* (ATCC 25922) Gram (-) were also evaluated.

For the agar disk diffusion method, the M02-A12 protocol (*22*) was used with some modifications for natural products. The absorbance scale [ABS] of 0.08 was used, which corresponds to 0.5 on the McFarland scale. Five concentrations of the extracts were tested on each plate. Dimethyl sulfoxide [DMSO] was used as the negative control, and tetracycline was used as the positive control. A volume of 5 µl was applied to each disc.

RESULTS AND DISCUSSION

Proximate Composition

The results of the centesimal composition of the peel, seed, and pulp are shown in Table 1. The values found for moisture on a dry basis ranged from 7.8 to 12.2 g 100 g^{-1}. The peel showed a moisture content of 9.8 g 100 g^{-1}, while the seed had the lowest value (7.8 g 100 g^{-1}) and the pulp the highest (12.2 g 100 g^{-1}). These differences were significant and can be attributed to the structural characteristics of each part of the fruit, such as the higher water retention in the pulp. These values are in accordance with current regulations for vegetable flours, which limit the moisture content to a maximum of 15% (*23*). Moisture content is essential information in food composition and is one of the commonly evaluated parameters, as this data can serve as an indicator of product quality, since it has a direct influence on storage (*24*). Results of the study by Reis and Schmiele (*25*) they are similar to this, as guabiroba (*Campomanesia cambessedeana* Berg.) and cagaita (*Eugenia dysenterica*) also exhibited a significant moisture content.

The ash content ranged from 2.18 to 3.96 g 100 g^{-1}, with the highest values found in the pulp and the lowest in the seed, showing significant differences between all three fractions. The peel and pulp flours exhibited higher ash concentrations compared to the seed. This is in line with Uchoa *et al.* (*26*), who argue that high ash levels may be related to a greater accumulation of minerals.

The protein content ranged from 1.47 to 1.77 g 100 g^{-1}. The peel had the highest value (1.77 g 100 g^{-1}), followed by the pulp (1.66 g 100 g^{-1}), while the seed had the lowest value (1.47 g 100 g^{-1}). Despite these differences, the values found between the peel and the pulp were not significantly different. These results are consistent with the study by Roesler *et al*. (*27*), which also reported differences in protein concentrations in different parts of several fruits from the Cerrado.

The lipid content ranged from 0.29 to 1.69 g 100 g^{-1}, with significant differences only between the seed and the other fractions. The seed had the highest lipid content (1.69 g 100 g^{-1}), while the peel had the lowest (0.29 g 100 g^{-1}), and the pulp had intermediate values (0.33 g 100 g^{-1}). These results are consistent with studies that highlight the high lipid concentration in seeds (*28*). In a study where the authors analyzed the antioxidant capacity of fruits from the Cerrado, the centesimal composition results of *Swartzia spp. langsdorffii*, a fruit from the Cerrado commonly known as Banha-de-Galinha, were similar only in the lipid content of the peel (0.29±0.02 %/m.m^{-1}) and pulp (0.46±0.15 %/m.m^{-1}) (*27*).

The crude fiber values varied significantly across all fractions, ranging from 2.1 g 100 g^{-1} in the pulp to 16.90 g 100 g^{-1} in the peel. The peel had the highest levels, standing out as an important source of dietary fiber. In contrast, the seeds had intermediate values (5.27 g 100 g^{-1}), and the pulp had the lowest. These results highlight that both the peel and seed have a high crude fiber content, a classification that applies when the portion of the product ready for consumption provides at least 2.5 g of fiber (*29*). These values are similar to the study on the chemical characterization of native fruits from the Cerrado, where fiber values ranged from 1.04 to 11.14 g 100 g^{-1} (*30*).

The carbohydrate content ranged from 68.19 to 81.54 g 100 g^{-1}. The seeds had the highest content (81.54 g 100 g^{-1}), followed by the pulp (79.06 g 100 g^{-1}) and the peel (68.19 g 100 g^{-1}), with no significant differences between the pulp and the seed. The seeds contain a considerable amount of carbohydrates, as they play a crucial role as an energy source for the initial growth of the plant. During germination, the stored carbohydrates are released to support the embryo and the early stages of development (*31*).

The total energy value (TEV) ranged from 282.45 to 347.25 kcal/100 g. The seeds had the highest energy value (347.25 kcal/100 g), followed by the pulp (325.85 kcal/100 g) and the peel (282.45 kcal/100 g). This difference can be attributed to the higher lipid concentration in the samples with a higher TEV, as this macronutrient is a concentrated source of energy according to the Atwater conversion.

Technological Evaluations

The results of the technological analyses of the peel, seed, and pulp fractions (Table 2) reveal significant differences in the evaluated characteristics, such as Water Absorption Capacity [WAC], Oil Absorption Capacity [OAC], Water Solubility Capacity [WSC] and Milk Absorptive Capacity [MAC]

The Water Absorption Capacity [WAC] of the samples ranged from 0.39 g/g (pulp) to 3.79 g/g (seeds), with the peel showing intermediate values (3.68 g/g). These values are directly related to the fiber content (Table 1) and their category based on their characteristics. The high WAC observed in the seeds and peel is likely attributed to the higher amount of soluble fibers, which have a high water absorption capacity. In contrast, the low and significant WAC of the pulp can be explained by its composition, which is richer in carbohydrates and has a lower fiber content, with fibers likely being higher in their insoluble form, which has characteristics of high viscosity and fermentation (*32,33*).

The Oil Absorption Capacity [OAC] values ranged from 1.83 g/g to 2.32 g/g. The pulp fraction showing the highest value (2.32 g/g), followed by the peel (2.29 g/g), while the seeds had the lowest (1.83 g/g), with no significant differences between the peel and pulp. CAO is an important parameter in the food industry and in food formulations, for enhancing flavor and texture. A lower OAC favors the use of the food in fried products, as it promotes crispiness (*34*).

For the Milk Absorption Capacity [MAC], the values ranged from 0.41 g/g to 4.90 g/g, with significant differences across all fractions. The peel showed the highest value (4.90 g/g), while the pulp had the lowest (0.41 g/g). The seeds also had low values (1.20 g/g). This technological capacity is a crucial parameter for the preparation of dairy-based products such as desserts, cream cheese, and sweets. Different results were found in a study conducted with Buriti peel flour (*Mauritia flexuosa*), comparing the results of the two peels. The Buriti peel had a slightly lower milk absorption capacity (4.58 ± 0.56 g/g) (*35*). This difference in results can be correlated with the particular characteristics and properties of each plant.

The Water Solubility Capacity [WSC] values showed a significant variation, ranging from 22.07% in the seeds to 90.78% in the pulp. The peel showed intermediate values

(23.61%). The high value observed in the pulp may be associated with a greater presence of soluble fibers, while the lower solubility in the seeds and peel can be attributed to their more rigid structural composition. Flours with a high degree of solubility favor the uniformity of ingredients, as this parameter is related to the proportion of dissolvable molecules in the dry sample (*36*). This characteristic may have implications for the technological use of each part of the fruit in different industrial applications.

In the gelation capacity analysis, there was a total absence of gel formation at all concentrations for all three fractions of Banha-de-Galinha. The peel flour of Guapeva at concentrations of 2% and 5% formed a weak gel, but at 10%, it formed a more resistant gel. Viscosity is a parameter related to the ability of starch to expand its granules when heated, hydrate, and retain water. Therefore, when there is a significant amount of starch granules with this capability, high viscosity and gel formation occur (*38*). In the study on the characterization of Maracujá-do-cerrado (*Passiflora setacea* DC), the gelation capacity results of the passion fruit peel flour partly corroborate this study. For concentrations of 2%, 4%, 6%, 8%, and 10%, no gel formation was observed, and there was also water accumulation at the bottom of the tube, which was a negative result. However, at the 12% concentration, the result was positive, with gel formation at the top of the tube and no water accumulation at the bottom (*37*).

When comparing these studies, in the case of the pulp, which showed high water solubility, the absence of gelation can be explained by the high predominance of soluble carbohydrates and the low concentration of soluble fibers. For the peel and seeds, the lack of gelation may be associated with the high concentration of insoluble fibers. Insoluble fibers do not have the ability to dissolve in water, which prevents them from forming gels (*38*). Some authors believe that this gel formation capacity may also be related to the presence of starch. However, in the test using Lugol (Table 3), no starch was detected in any of the three fractions (*39*).

Thus, the observed results highlight the need to combine these samples with other ingredients that have gel-forming properties (ex. pectin, xanthan gum, or alginate) to promote gel formation in food formulations using any part of the fruit. Moreover, the total absence of gel formation at both low and higher concentrations of the three plant fractions can be explained by the lack of starch observed in Table 3 and the fiber composition of the fractions.

Phytochemicals

The phytochemical analysis of the peel, seed, and pulp fractions (Table 3) revealed significant differences in the presence of bioactive compounds, with some variations

observed between the hydroalcoholic extract and dry plant material conditions. Phytochemical studies involve steps such as the isolation, identification, and structural determination of the main compounds present in plants, especially those derived from secondary metabolism, which may or may not be related to biological activity. This information helps identify the plant species and, together with biological activity tests, enables the analysis and characterization of bioactive fractions or compounds (*40*).

In the saponin and tannin analyses, both the hydroalcoholic extract and the ground dry plant material showed positive results, as indicated by the observation of persistent foam for saponins and abundant turbidity and precipitation upon contact with at least one of the reagents for tannins. The bark stood out with the presence of condensed tannins with a green coloration. Saponins are compounds derived from the secondary metabolism of plants, known for forming foam in aqueous solutions. Their amphiphilic structure combines a lipophilic part (triterpene or steroid) and a hydrophilic part (sugars), which gives them detergent-like properties (*41*). Tannins, on the other hand, are water-soluble phenolic compounds that interact with proteins. Tannins can be classified into hydrolyzable and non-hydrolyzable types. They are characterized by their ability to bind with proteins in animal skin, inhibiting the putrefaction process, and their relation to wound healing (*42*).

Regarding alkaloids, the peel showed positive results only with the Sonneschein reagent under both conditions analyzed. In the seed, the result was positive with all reagents except Mayer's in both sample conditions. In the pulp, the presence of alkaloids was confirmed in four of the reagents under both conditions. Plant extracts containing alkaloid compounds have been used as medicines and also as poisons since the Neolithic period (*43*). In the analysis of the presence of anthraquinones, both sample conditions resulted negative for all fractions (peel, pulp, and seed). For flavonoids, the samples were also negative in the condition of ground dry plant material.

In the test for coumarins, the peel showed a positive result only in the hydroalcoholic extract condition, with a characteristic yellow coloration when subjected to 1M sodium hydroxide. In the seed, the presence of coumarins was evident both in the hydroalcoholic extract and in the ground dry material, with a specific coloration in both conditions. However, the pulp did not show any presence of coumarins in any of the samples analyzed. Coumarins play an important role in the physiology of plants, acting as antioxidants. Additionally, they can significantly aid research by preventing and treating diseases due to their ability to exert non-covalent interactions with protein structures, offering a wide range of biological activities (*44*). Polysaccharides were not detected in any of the samples in the hydroalcoholic extract condition, as indicated by the test with

iodine, which did not show the blue coloration typically associated with the presence of starch.

Therefore, the presence of saponins, tannins, alkaloids and coumarins was evidenced in all three fractions of the fruit in at least one form of manipulation (flour or extract) and in at least one reagent. As for anthraquinones, polysaccharides and flavonoids, the result was negative in all three fractions in the forms of manipulation analyzed.

Looking at other studies with similar analyses, in the study by Magalhães *et al.*, similar results were obtained. The authors compared results from previous studies of 9 plant species from the *Swartzia spp*. One of these analyses was for Saponins, which showed positive results for *Swartzia spp. schomburgkii*, *Swartzia spp. apetala*, *Swartzia spp. Langsdorffii*, and *Swartzia spp. Simplex*. (*45*). Another study conducted with extracts from the bark of tree legumes aimed at identifying the classes of substances, 5 of which belong to the *Swartzia spp*. The authors identified the presence of Saponins in 4 species (*Swartzia spp. argentea*, *Swartzia spp. macrocarpa*, *Swartzia spp. panacoco*, and *Swartzia spp. polyphylla*) and Alkaloids in 3 species (*Swartzia spp. argentea*, *Swartzia spp. laevicarpa*, and *Swartzia spp. polyphylla*). (*46*). It can be observed that even from different species, there is a similarity in their phytochemical characteristics.

Antibacterial capacity

The extract of *Banha-de-Galinha* was tested at doses of 130.63, 65.31, 32.65, 16.32, and 8.16 g/mL for the peel; for the seed, the concentrations were 227.81, 113.90, 56.95, 28.47, and 14.23 g/mL; and for the pulp, they were 290.22, 145.11, 72.55, 36.27, and 18.12 g/mL. The results obtained in the antimicrobial test with the peel, seed, and pulp samples are shown in Table 4. All fractions (peel, seed, and pulp) showed no detectable antibacterial activity at any of the tested concentrations against the bacterial strains *Salmonella typhimurium*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*, as evidenced by the complete absence of inhibition zones.

When reviewing other studies on the antibacterial activities of fruits from the Cerrado, different results from this research can be observed. The hydroalcoholic extract of *Brosimum gaudichaudii* leaves (mamacadela) showed positive antibacterial activity against *Staphylococcus aureus* ATCC 25923, with an inhibition zone of 18mm at the minimum concentration of the extract. In the same study, the authors emphasize the significant influence of phytochemicals on the biological activities of plants. Comparing the phytochemical profiles of the hydroalcoholic extract of both plants, it is noted that

only tannins are present in both species. In *Brosimum gaudichaudii*, flavonoids are also present, which were absent in the fractions of Banha-de-Galinha (*47*). Another study on *Lafoensia pacari* (mangaba brava) leaves demonstrated positive results against *Escherichia coli* and *Staphylococcus aureus*. Regarding the phytochemicals, a strong positive reaction was observed for hydrolyzable tannins and flavanones (*48*).

Miranda *et al.* state that the cell wall of Gram-positive bacteria is more permeable than that of Gram-negative bacteria. Additionally, they have observed the capacity of mutation and resistance in these bacteria against antibacterial agents (*49*). Regarding the phytochemicals, it seems that in general, they exhibit effective activity against bacteria, but two classes stand out among the others. Tannins possess antimicrobial properties associated with the breakdown of an ester bond of gallic acid, acting as a natural defense against microbial infections. Flavonoids, such as flavonols and flavanones, produced by plants in response to infections, also show efficacy against various microorganisms (*50*).

CONCLUSIONS

Based on the results obtained, it is clear that the different parts of the fruit present distinct centesimal compositions, technological characteristics, and phytochemical profiles, directly influencing their features and applications. This study provided important information that allowed for the discovery of various properties and highlighted the value of a Cerrado fruit, but it also emphasizes the importance and need for further studies to explore the full potential applications of this fruit.

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CONFLICT OF INTERESTS

This research has no conflict of interest.

CONTRIBUTION OF THE AUTHORS

The PBD conceived the research idea, collected the samples, and performed their fractionation, conducted and interpreted the analyses, and wrote the research in the form of an article. The MCP contributed to the analysis and interpretation. The LFC designed the research plan, organized the methodologies for the analyses, directed the project, assisted in writing the article, and approved the final version for publication.

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Fig 1. Tree Banha-de-Galinha

Fig 2. Fruit Banha-de-Galinha

Table 1. Proximate Composition of the Peel, Seed and Pulp.

Variables (g 100 g^{-1})	Dry basis values of the peel [1]	Dry basis values of the seed [1]	Dry basis values of the pulp [1]

Dry basis humidity	9,8 ± 0,16[b]	7,8 ± 0,07[c]	12,2 ± 0,05[a]
Ashes	2,74 ± 0,08[b]	2,18 ± 0,15[c]	3,96 ± 0,24[a]
Proteins	1,77 ± 0,13[ab]	1,47 ± 0,02[c]	1,66 ± 0,03[ab]
Lipids	0,29 ± 0,08[bc]	1,69 ± 0,08[a]	0,33 ± 0,01[bc]
Crude Fiber	16,90 ± 0,66[a]	5,27 ± 1,44[b]	2,1 ± 1,00[c]
Carbohydrates	68,19 ± 0,82[c]	81,54 ± 1,34[ab]	79,06 ± 0,95[ab]
TEV (kcal 100 $^{g-1}$)	282,45	347,25	325,85

[1] mean ± standard deviation of three technical replicates [abc] Means in the same row with the same superscript letters do not differ statistically from each other by Tukey's test ($p<0.05$).

Table 2. Technological Analyses of the Peel, Seed and Pulp.

Variables	Dry basis values of the peel [1]	Dry basis values of the seed [1]	Dry basis values of the pulp [1]
WAC (g g^{-1})	3,68 ± 0,39[ab]	3,79 ± 0,20[ab]	0,39 ± 0,00[c]
OAC (g g^{-1})	2,29 ± 0,08[ab]	1,83 ± 0,004[c]	2,32 ± 0,17[ab]
MAC (g g^{-1})	4,90 ± 0,36[a]	1,20 ± 0,01[b]	0,41 ± 0,00[c]
WSC (%)	23,61 ± 0,04[bc]	22,07 ± 0,01[bc]	90,78 ± 0,008[a]

[1] mean ± standard deviation of three technical replicates [abc] Means in the same row with the same superscript letters do not differ statistically from each other by Tukey's test ($p<0.05$).

Table 3. Phytochemical Results of the Peel, Seed and Pulp.

Test	Reaction Used	Peel Results	Seed Results	Pulp Results
Saponins[1]	Distilled water	(+)	(+)	(+)
Saponins[2]	Distilled water	(+)	(+)	(+)

Tannins [1]	Gelatin 2,5% in NaCl 5%	(+)	(+)	(-)
	$Cu(AcO)_2$ 4%	(+)	(+)	(+)
	$Pb(AcO)_2$ 10%	(+)	(+)	(+)
	$FeCl_3$ 2%	(-)	(-)	(-)
	$Pb(AcO)_2$ 10% y $C_4H_8O_2$	(-)	(-)	(-)
Tannins [2]	Gelatin 2,5% in NaCl 5%	(-)	(-)	(-)
	$Cu(AcO)_2$ 4%	(-)	(-)	(+)
	$Pb(AcO)_2$ 10%	(+)	(-)	(+)
	$FeCl_3$ 2%	(+ green)	(-)	(-)
	$Pb(AcO)_2$ 10% y $C_4H_8O_2$	(-)	(+)	(-)
Alkaloids [1]	Dragendorff	(-)	(+)	(+)
	Mayer	(-)	(-)	(-)
	Bouchardat/Wagner	(-)	(+)	(+)
	Sonneschein	(+)	(+)	(+)
Alkaloids [2]	Dragendorff	(-)	(+)	(+)
	Mayer	(-)	(-)	(+)
	Bouchardat/Wagner	(-)	(+)	(-)
	Sonneschein	(+)	(+)	(+)
Anthraquinones[1]	Hydrochloric acid 10%	(-)	(-)	(-)
Anthraquinones[2]	Hydrochloric acid 10%	(-)	(-)	(-)
Flavonoids[1]	Concentrated sulfuric acid	(-)	(-)	(-)
Coumarins [1]	Sodium hydroxide 1M	(+)	(+)	(-)
Coumarins [1]	Sodium hydroxide 10%	(-)	(+)	(-)
Coumarins [2]	Sodium hydroxide 1M	(-)	(-)	(-)
Polissacarídeos[1]	Lugol's solution	(-)	(-)	(-)

[1]Hydroalcoholic extract; [2]Ground dry plant material. (+) presence (-) absence.

Table 4. Antibacterial test results of the 5 concentrations of bark, seed, and pulp.

Variables[1]	**Peel[1a]**	**Seed[1a]**	**Pulp[1a]**
Tetraciclina	(+)	(+)	(+)
DMSO	(-)	(-)	(-)
S. typhimurium	(-)	(-)	(-)
S. aureus	(-)	(-)	(-)

P. aeruginosas	(-)	(-)	(-)
E. coli	(-)	(-)	(-)

[1] mean [a] result representing all tested concentrations of the sample (+) presence of inhibition zone (-) absence of inhibition zone.

2. LAYOUT DA REVISTA PARA PUBLICAÇÃO

Title (Arial, Font size 13, Bold, centred;
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[Title should be concise and relevant to the topic of manuscript, pointing out results rather than methods; keep in mind higher ranking key words in search engines]

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Running head: Please give a suggestion of a running head

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[1]First Author's Affiliation (full address: name of institution, street, city, state [where applicable], country)

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SUMMARY (Arial, BLOCK CAPITALS, Font size 11)

(Arial, Font size 11, regular, alignment justified) Summary should not be longer than 350 words. Numerical results in this section should be limited to only those that are indispensable for the comprehension of the research contribution of the paper. No abbreviations, equations, illustrations, figures, tables or references should appear in the Summary. The information in the Summary should agree with the rest of the text and all information in it should appear in the body of the paper. Summary and key words should clearly reflect the content of the manuscript. It should be divided in the following paragraphs:

Research background. Briefly give your interpretation of research in this area so far, what is its current state and what your study aims to accomplish.

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Results and conclusions. Explain briefly the most relevant results and conclusions.

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Keywords: (Arial, bold, Font size 11) maximum 6 words (Arial, lower case, Font size 11, regular, *i.e*. not italic, except names of microorganisms, genes or Latin phrases), use semicolon between the key words, no separate line for each key word, no punctuation at the end. Do not use generic and too general key words

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The whole text should be 500-900 words fully justified across the full length of the printed area. Text should be written in Arial Font size 11.

References should be cited sequentially, in round brackets, with only the ordinal number of the reference in italic (*1*). If more than one reference is cited in the same brackets, they should be separated by commas, without spacing (*2,3*), and use unspaced en dash to join a range of three or more consecutive references (*4-8*).

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Each paper will have sections based on the type of work that is presented. This template should be used for original scientific papers, preliminary communications and scientific notes. Word count is limited to 7000, 6000 and 5000, respectively.

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Sections Materials and Methods, and Results and Discussion may contain subsections. Do not use the same headings in these two sections. If authors would like to divide the main sections of their paper in further subsections, they should use the format suggested above for naming these subsections.

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Text should appear in separate line from the subheading.

Tables and Figs. may be mentioned and discussed in Materials and Methods, but only if they do not present the results and if they are relevant for describing the used methodology or samples.

When using equations, in the text they should be written in a separate line and symbols used in the equations need to be explained below the equation, specifying the units, as follows:

$$V(\text{inoculum})=(0.05\cdot V(\text{fermentation})/A(\text{seed culture})) \quad /1/$$

where V is the volume (in mL), 0.05 is the initial absorbance (A) at 595 nm and A is the absorbance of seed culture solution. When mentioned in text, they should be abbreviated as follows: Eq. 1 (if citing more than one in the same sentence: Eqs. 1 and 2).

All used materials and apparatus should be specified, providing full details (model number/name; manufacturer, city, state (where applicable), country of the manufacturer, do not cite a distributor).

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Acknowledgements to colleagues, institutions or companies for support, donations of materials or any technical or other form of assistance need to be put here. This section is optional.

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FUNDING (Arial, BLOCK CAPITALS, Font size 11)

Details of all funding sources for the research should be written here. Provide full official funding agency name(s) and grant number(s).

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If the manuscript contains supplementary material that will be published only online, then this chapter must be added with the following statement: All supplementary materials are available at: www.ftb.com.hr.

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5. Ujhelyi G, Vajda B, Béki E, Neszlényi K, Jakab J, Jánosi A, et al. Surveying the RR soy content of commercially available food products in Hungary. Food Control. 2008;19:967-73. https://doi.org/10.1016/j.foodcont.2007.10.004

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12. Harrison RG, Bagajewicz MJ. Predicting the solubility of recombinant proteins in *Escherichia coli*. In: García-Fruitós E, editor. Insoluble proteins, methods in molecular biology (Methods and protocols), vol. 1258. New York, NY, USA: Humana Press; 2015. pp. 403-8. https://doi.org/10.1007/978-1-4939-2205-5_23

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