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Characterization of mutamba (*Guazuma ulmifolia* LAM.) fruit flour and development of bread

Renato Queiroz Assis[a], Karina Luzia Andrade[b], Lílian Emanoela Gomes Batista[c], Alessandro de Oliveira Rios[a], Disney Ribeiro Dias[d,*], Eliane Augusto Ndiaye[c], Éllen Cristina de Souza[d]

[a] Institute of Food Science and Technology, Federal University of Rio Grande do Sul (UFRGS), Av. Bento Gonçalves, 9500, Agronomia, 91501-970, Porto Alegre, Rio Grande do Sul, Brazil
[b] Institute of Exact and Earth Sciences, Federal University of Mato Grosso (UFMT), Av. Valdon Varjão, 6390, 78600-000, Barra do Garças, Mato Grosso, Brazil
[c] Institute of Biological and Health Sciences, Federal University of Mato Grosso (UFMT), Av. Valdon Varjão, 6390, 78600-000, Barra do Garças, Mato Grosso, Brazil
[d] Department of Food Science, Federal University of Lavras (UFLA), Campus Universitário, 37200-000, Lavras, Minas Gerais, Brazil

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ABSTRACT

This work aims to characterise chemical and phytochemical mutamba (*Guazuma ulmifolia* LAM.) flour and evaluate its addition in whole wheat bread. The phytochemical analysis revealed the presence of phenols, tannins, saponins, steroids, resins, quaternary bases, quinones, flavonoids and triterpenoids. For the test of *Artemia salina* Leach, the methanolic extract of the fruit showed a lethal dose of 36.59 μg/mL, with antioxidant activity by the 2, 2-Diphenyl-1- picrylhydrazyl (DPPH) method and for the β-carotene system. The mutamba flour presented a low lipid content and a high crude fibre content (26.90 ± 0.37%). The optimal concentration of the meal added in the bread was 5%, in which its use demonstrates potential application in the development of new products using fruits of the Cerrado in the diet.

1. Introduction

Mutamba is the popular name of *Guazuma ulmifolia* Lam., a species of the family Sterculiaceae, whose fruits present a dry bark and the seeds are inserted in a mucilaginous pulp that has a sweet flavour, which can be found in Brazil, Mexico, Venezuela and Peru (Carvalho, 2007; Maldini et al., 2013; Morais et al., 2017). The Brazilian Cerrado fruits, such as mutamba, have aroused the attention of several studies that evaluate its chemical characterisation and are often considered a good alternative for the consumption of nutrients such as fibres, proteins, minerals, carotenoids, vitamins and phenolic compounds (Assumpção et al., 2014; Cardoso et al., 2011; Dalla Nora et al., 2014; Haminiuk et al., 2011; Morais et al., 2017; Schiassi et al., 2018; Siqueira et al., 2012).

Some studies have evaluated the extracts obtained from the bark and leaves of *guazuma ulmifolia* Lam., which is characterised by the presence of antioxidant compounds (catechin, chlorogenic acid, caffeic acid, rutin, quercitrin, quercetin and luteolin) (Morais et al., 2017), demonstrating an antidiabetic effect of stimulating the absorption of glucose in insulin-sensitive and insulin-resistant adipocytes without affecting the development of adipose tissue (Alonso-Castro and Salazar-Olivo, 2008). Furthermore, the ethanolic extract of the bark and flowers contributed to the protection of the gastric mucosa of rats induced to ulcerogenic agents, a behavior related to the lower propagation of inflammation and antioxidant effect as stated by Berenguer et al. (2007). However, the majority of the studies evaluate the extraction and characterisation of extracts obtained from bark, leaf and flowers as a raw material for the potential application and development of new food products, while the fruits were not evaluated and are underexplored for consumption (Pineli et al., 2015; Rocha and Santiago, 2009; Silva et al., 2016).

In this context, obtaining information on the fruits of mutamba may contribute to the identification of the classes of compounds of pharmacological and nutritional interest, in which most studies evaluate the characterisation of the leaves and the bark of this species, where the fruits are still poorly studied as to their physicochemical properties and application/consumption. Thus, this work aims to develop a flour from the fruits of mutamba (*Guazuma ulmifolia* Lam.) and evaluate its addition in the formulation of whole wheat bread, referring to a previous characterisation of its chemical composition, antioxidant, cytotoxic

* Corresponding author.
E-mail address: diasdr@ufla.br (D.R. Dias).

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activity and phytochemical screening.

2. Material and methods

2.1. Materials

The fruits of mutamba were collected from the region of Pontal do Araguaia, MT, Brazil, between August and September of 2014. The fruits were stored at −18 °C until analysis.

2.2. Phytochemical analysis

The fruits were dried in an oven with forced air circulation at 65 °C (Nova Ética, model 402/D) and ground in a mill (IKA, model A11 basic). The compounds were extracted with two different solvents of respective hydrophilic and hydrophobic character. Hydrophilic and lipophilic extracts were obtained from the addition of the sample (100 g) in 70% ethyl alcohol (800 mL) and chloroform (400 mL), where the extraction was performed for 7 days for complete removal of the compounds. The extract obtained was filtered and concentrated under reduced pressure in a rotary evaporator (Fisatom model 801/802, São Paulo, SP, Brazil). The classes of the secondary metabolites were characterised according to the methodology described by Matos (1997).

2.3. Cytotoxic activity

The evaluation of toxicity to *Artemia salina* was performed according to the methodology described by Meyer et al. (1982). The lethal dose (LD_{50}) was determined by counting live and dead microcrustaceans after 24 h of incubation; the analysis was performed in triplicate.

2.4. Qualitative evaluation of the antioxidant activity by bioautography

The antioxidant activity analysis was performed according to the method described by Silva and Gomes (2008) with some modifications.

2.5. Development of whole wheat bread containing mutamba flour

2.5.1. Drying of fruits

The fruits were dried in an oven with forced air circulation (65 °C) (Nova Ética, model 402/D) until constant weight was reached, ground in a Wiley mill, sieved to obtain a product with uniform granulometry, and the obtained flour was stored in plastic packaging. During the process, samples were taken every 30 min to get the drying curve.

2.5.2. Granulometry of the flour

The granulometry of the flour (100 g) was obtained by shaking the sample for 10 min in a set of sieves (65, 200, 400 and 500 *mesh Tyler*, with mesh openings of 212, 75, 38 and 25 μm, respectively); after this period, the fractions retained in each sieve were weighed and expressed as a percentage (AACC, 2000).

2.5.3. Functional properties and water activity of flour

The water activity was performed using the Aqualab equipment; the reading was performed directly on the apparatus. Water holding capacity (WHC) and water absorption capacity (WAC) were determined according to Anderson et al. (1969). To determine the WAC, 2.5 g of flour was placed in a centrifuge tube and distilled water (30 ml) was added. The samples were shaken for 30 min and then centrifuged (3000 rpm–10 min). The supernatant was removed (10 mL) and subjected to drying (105 °C). The WHC was obtained by the relation between the weight of the evaporation residue and the dry weight of the sample according to the equation:

Table 1
Ingredients used for the formulation of breads with different concentrations flour of the fruits.

Ingredients	Flour of mutamba		
	5%	7%	9%
Whole wheat flour (g)	100	100	100
Sugar (g)	20	20	20
Oats (g)	7	7	7
Brazil nuts (g)	7	7	7
Margarine (g)	8	8	8
Yeast (g)	3	3	3
Salt (g)	1,6	1,6	1,6
Milk (mL)	200	200	200
Eggs (u)	1	1	1

$$WAC = \left(\frac{Centrifugation\ residue}{Sample\ weight\ \times Evaporation\ residue} \right) \times 100$$

$$WHC = \left(\frac{Evaporation\ residue}{Sample\ weight} \right) \times 100$$

The analysis was performed in triplicate, and the result obtained was expressed as the mean ± standard deviation.

2.5.4. Preparation of formulations

The flour of the mutamba fruit was added in partial substitution of whole wheat flour in proportions of 5%, 7% and 9% (m/m) (Table 1).

2.5.5. Production process

The dough was obtained with approximately 50% of the flour, milk, sugar and yeast; it was fermented for 15 min. The other ingredients were added and mixed until a homogeneous mass was obtained (Fig. 1). The mass was divided (570 g) and rested for 20 min. After this period, it was modelled, oats was added on its surface and it was submitted to fermentation (3–4 h). The bread was baked in a conventional oven (40 min at 180 °C), cooled to room temperature and stored.

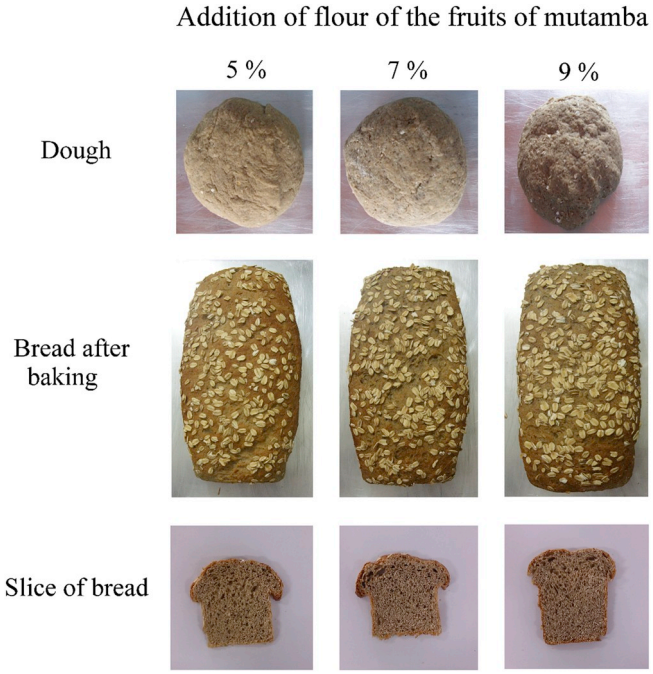

Fig. 1. Whole wheat bread with different concentrations of flour from the mutamba fruits.

2.5.6. Shelf life

The breads were stored in plastic packaging at room temperature (25 °C) and analysed periodically for weight loss, moisture, volume and colour. The weight loss was determined with respect to the initial mass. The volume was obtained according to Gutkoski et al. (2007) through the displacement of millet seed. The colour was determined with a colorimeter MiniScan EZ Hunterlab by using the CIELab scale. The analyses were performed until the growth of fungi in the sample, determining the shelf life of the products.

2.5.7. Microbiological analysis

Microbiological analysis was performed considering the coliform count at 45 °C and the presence of *Salmonella* sp. (BRASIL, 2001), which were determined using the methods described by the American Public Health Association (APHA, 2001).

2.5.8. Sensory analysis

Sensory evaluation was performed with 100 non-trained judges, who were aged 17–53 years. For global evaluation of samples, a structured hedonic scale with 9 points was used, where 1 represented "dislike extremely" and 9 "extremely liked". The intention to buy was also analysed with a hedonic scale structured with 5 points, in which 5 represented "would certainly buy it" and 1, "would certainly not buy it" (Meilgaaard et al., 1999). The sensorial analysis project was approved by the Ethics Committee of the Federal University of Rio Grande do Sul, process number 1.716.605.

2.5.9. Chemical analysis of flour and bread

The chemical composition of the sample that received a high score in the sensorial analysis was determined. The moisture, lipids, protein, crude fibre and ash contents were determined according to the methodology described by the AOAC (2011). Carbohydrates were determined by difference. The energy value was estimated by the Atwater conversion values of 4 kcal/g protein or carbohydrate and 9 kcal/g lipid (Merrill and Watt, 1973).

2.5.10. Statistical analysis

Statistical analysis was performed using the software Statistica 12.0 (Statsoft Inc., USA), where the results were submitted to the analysis of variance (ANOVA) and the Tukey test, adopting a level of significance of 5%. The analyses were performed in triplicate, and the results were expressed as the mean ± standard deviation.

3. Results and discussion

3.1. Preliminary chemical analysis

Preliminary phytochemical screening reveals the presence or absence of phytochemicals in the hydrophilic or lipophilic extracts of the fruits of mutamba, such as glycosides, saponins, coumarins, alkaloids, terpenoids, flavonoids, tannins and phenolic compound (Table 2).

The test for phenols was positive in the hydroalcoholic extract – compounds that are present in the form of esters or heterosides, soluble in water and polar organic solvents. The tannin characterisation reaction was positive for the hydroalcoholic extract and negative for the chloroform extract. However, after the saponification of the apolar extract, the presence of these constituents was found. After acid hydrolysis, the presence of flavanones and flavanols in the hydroalcoholic extract was confirmed. The analysis for quaternary bases, which is different from the alkaloid prospecting test, was positive only for the hydroalcoholic extract, where these compounds are generally in ionised form and are soluble in the polar fraction of the extract. The behavior was observed for coumarins, in which the presence of a benzene ring in its structure and its affinity for a fraction of the lipophilic extract confirmed the existence of this compound in the mutamba fruit. For the quinones test, the result was positive after acid hydrolysis of the hydroalcoholic extract, which is different from the analysis for anthranols, indicating that this group is not found in the studied fruit.

Among the secondary plant metabolites, the tests were positive for steroid or terpenoid aglycones in the hydroalcoholic extract and also for steroids in the chloroform extract, in which these compounds were also found in the bark of mutamba (José da Silva et al., 2007). The hydroalcoholic extract was negative for saponins but confirmed the presence of resins, substances characterised as liposoluble mixtures of volatile and non-volatile terpenes/phenolic compounds secreted in specialised structures.

Ethanolic extract of *Guazuma ulmifolia* Lam leaves showed antioxidant activity related to the presence of some compounds found in preliminary phytochemical screening, such as flavonoids and phenolic acids, which evidenced the importance of the study and characterisation of the fruits of mutamba (Morais et al., 2017). Additionally, the compounds identified for the methanolic extract of the fruits of *Annona muricata* (Soursop) (Agu and Okolie, 2017), buriti and babassu (Nobre et al., 2018) and ethanolic extract of mangaba fruits (Assumpção et al., 2014), in which the presence of these compounds may be related to antioxidant activity and antimicrobial activity (Agu and Okolie, 2017; Shahid-Ud-Daula et al., 2019).

3.2. Qualitative evaluation of the antioxidant activity by bioautography

The results of the analysis of the antioxidant activity by bioautographic methods are shown in Fig. 2. Furthermore, the compounds with antioxidant activity revealed by β-carotene showed a typically orange coloration. As revealed by DPPH, compounds having antioxidant activity develop a yellow-whitish colour, resulting from the reaction of donation of hydrogen atoms from the constituents of the extract to the developing reagents. Fig. 2 confirms the antioxidant activity of the extract in both cases. However, it is possible to observe a lower intensity in the coloration in the plate with a solvent of less polarity (n-hexane), which indicates that the constituent responsible for the activity has little apolar characteristics.

According to Kulisic et al. (2004) and Tepe et al. (2005), lipid compounds, such as those present in essential oils, have antioxidant activity and should be investigated by the β-carotene-linolenate method (BCB), as it is more sensitive to these substances than DPPH. Tepe et al. (2005) evaluated the antioxidative activity of the essential oil and various extracts of *Cyclotrichium origanifolium* (Labill.), in which the polar fractions inhibited the oxidation of the DPPH radical and the less polar fractions presented greater reduction potential by the BCB test. The antioxidant potential against the radical DPPH and β-carotene can be explained by the presence of polyphenols in the fruit extract, such as flavonoids and quinones characterised by preliminary phytochemical analysis, such as the presence of flavonoids in the lipophilic fraction used for the assay.

3.3. Cytotoxic activity

Several biological assays have been developed to be used for the monitoring of plant extracts, such as toxicity on *A. salina*, which is a rapid bioassay for the prior screening of plant extracts. The dose-response curve for mutamba extract is shown in Fig. 3, with an LD_{50} value of 36.59 μg/mL.

There was a lethality of 100% for the microcrustaceans from the concentration of 300 μg/mL; thus, fractionation of the crude methanolic extract in the concentrations of 25, 50, 75, 100, 125, 150, 175 and 200 μg/mL was performed. It was identified as active only for the hexane fraction, presenting an LD_{50} of 186.7 μg/mL. It was expected to have a lower value for the hexane fraction due to the separation and purification of the substances by polarity in the fractionation of the crude methanolic extract, but the possible synergism between molecules that confer activity to the extract, and which may have been separated during fractionation should not be disregarded.

Table 2
Characterization of the secondary metabolites present in hydroalcoholic (hydrophilic) and chloroform (lipophilic) extracts of the fruits of *Guazuma ulmifolia* Lam.

Compounds	Hydrophilic extract	Lipophilic extract	After acid hydrolysis		After alkaline hydrolysis	
			Hydrophilic extract	Lipophilic extract	Hydrophilic extract	Lipophilic extract
Phenols	++	0	–	–	–	+
Tannins	+++	0	–	–	–	+
Anthocyanins and anthocyanidins	0	0	–	–	–	0
Chalcones and aurones	0	0	0	–	–	0
Flavanonols	0	0	++	–	–	0
Leucoanthocyanidins	0	0	0	–	–	0
Catechins	0	0	0	–	–	S
Flavanones	S	0	++	–	–	0
Flavones, flavanols and/or xanthones	++	+++	0	–	–	S
Pentacyclic Triterpenoids	0	–	–	–	–	0
Free Steroids	++	–	–	–	–	+++
Saponins	+++	–	–	–	–	–
Strong Acids	0	0	0	–	–	S
Resins	+++	–	–	–	–	–
Alkaloids	0	0	–	–	–	–
Quaternary Bases	++	0	–	–	–	–

(+++) Very positive; (++) Positive; (+) Weakly positive; (S) Suspect; (0) Absence; (−) Not determined.

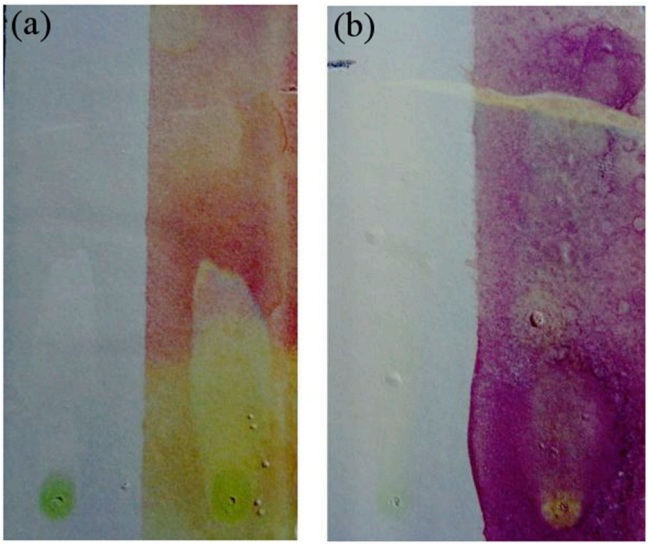

Fig. 2. Determination of antioxidant activity by bioautography: (a) test with β-carotene and with DPPH in n-hexane and (b) test with β-carotene and DPPH in n-hexane/ethyl acetate.

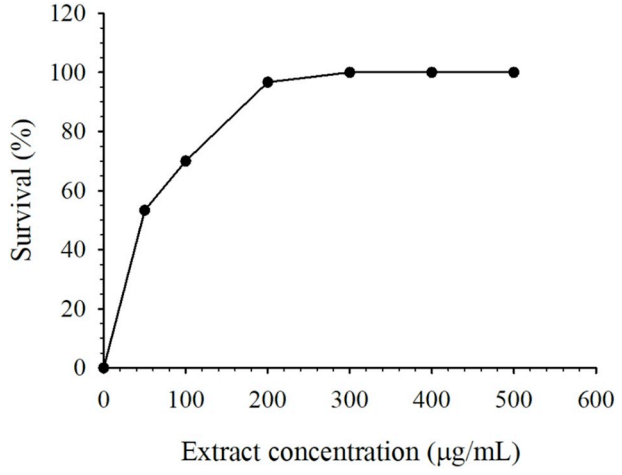

Fig. 3. Toxicity analysis of the crude methanolic extract of mutamba fruits against *Artemia salina*.

According to Lacerda et al. (2011), extracts with LD_{50} of less than 80 μg/mL are considered as toxic and those with LD_{50} of 80 μg/mL to 250 μg/mL as intermediates. The World Health Organization (WHO) defines toxic as any substance that has an LD_{50} value below 1.000 μg/mL for *A. salina*. In a cytotoxic test performed by Ali et al. (2013) on a methanolic extract of the leaves of *Urena lobata* L., an LD_{50} value of 37.50 μg/mL was detected. Meira-Neto and Almeida (2015) found an LD_{50} of 238 μg/mL, indicating that the crude ethanolic extract of the leaves of *Gossypium arboreum* L. is variable even in the same botanical family.

Fruit extracts of araticum (*Annona crassiflora*) and cagaita (*Eugenia dysenterica*) presented LD_{50} of 11.7 mg/mL and 57.0 mg/mL, respectively. The low LD_{50} value for araticum would probably be related to the presence of acetogenins, compounds found in the seeds of anocaceous fruit that may act in the inhibition of mitochondrial respiration (Fonseca et al., 2013). Assumpção et al. (2014) found an LD_{50} value of 219.2 ± 2.3 μg/mL for an extract of mangaba fruits (*Hancornia speciosa*), which is higher than that found in this study.

3.4. Development of whole wheat bread containing mutamba flour

3.4.1. Drying of fruits

This process occurred for 7 h (Fig. 4), with an initial moisture content of 34.56% and a final of 10.16%, with the fruits being

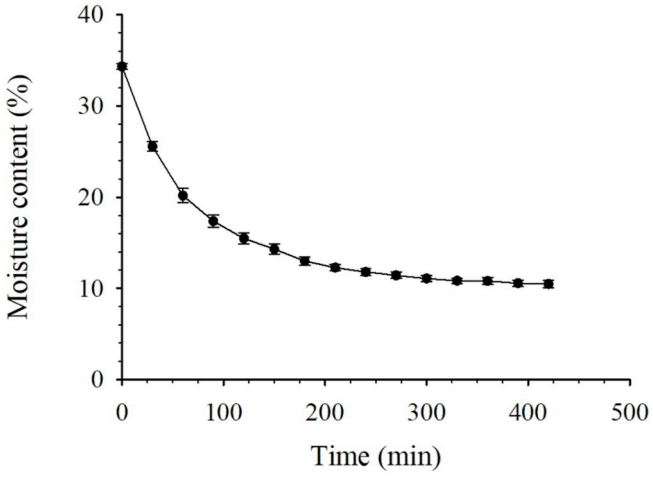

Fig. 4. Drying of the fruits of mutamba.

Table 3
Granulometric distribution of whole wheat flour (WWF), wheat flour (WF) and mutamba flour (MF).

Mesh Tyler	Pore size (μm)	WWF (%)	WF (%)	MF (%)
65	212	50	50	–
200	75	40	45	75
400	38	10	5	25
500	25	–	–	–

WWF: whole wheat flour; WF: wheat flour; MF: mutamba flour.

submitted to the milling process after the drying period. The highest moisture loss occurred in the first 4 h of drying (66.23%), with a decrease in the removal rate after this time.

3.4.2. Granulometry, yield and water activity and functional properties of flour

After the drying process, the fruits were submitted to the milling process, with 60% yield from a 2 kg sample and water activity of 0.391 ± 0.003, which can be considered to have low moisture and high stability during storage. Table 3 shows the granulometry of whole wheat flour (WWF), wheat flour (WF) and mutamba flour (MF). WWF and MF showed similar granulometry, with 50% of the flours retained in the sieve mesh *Tyler* 65 and 45% and 40% retained in the sieve mesh *Tyler* 200.

The wheat flour presented lower particle size when compared to the other flours; furthermore, the method for obtaining and the size of the particles can determine the product's homogeneity and the specific characteristics of the flour, where products with smaller particles absorb proportionally more water than products with larger particles (Silva et al., 2009). The flour presented the water absorption index and the water solubility index of 35.94 ± 2.37% and 4.58 ± 0.10%, respectively. The high-water absorption may be related to the high fibre content (Table 7), which may contribute to the maintenance of the moisture content of products when added in the formulation.

3.4.3. Shelf life of products

The samples were stored at room temperature, and the fungal growth was observed between days 8 and 9. Table 4 shows the parameters analysed during the shelf life of the products.

The moisture contents of the breads did not differ during storage ($p < 0.05$), which demonstrates that the mutamba flour possibly contributed to moisture retention. There was a slight variation in the volume of the samples, as the weight loss is directly related to the loss of moisture content; however, a difference in this parameter during storage was not presented. With the increase of the concentration of mutamba flour, there was a decrease in volume, which is related to the fibre content present in the flour. The increase in the fiber content in the samples interacted with the gluten chain, which is responsible for the retention of gases produced during the fermentation, obtaining a structure with less cohesion and decreasing sample size. However, there was no significant variation ($p < 0.05$) in this parameter during storage. A behaviour similar to that was observed by Silva et al. (2009), where the increase of the addition of flour "okara" led to a decrease in the volume of bread. Ho et al., (2013) evaluated the physicochemical characteristics of bread with partial substitution of wheat flour for banana stem flour and xanthan gum and observed a decrease in weight and volume. Furthermore, similar behaviour was observed by Ragaee et al. (2011) and Hathorn et al. (2008), who tested the partial substitution of wheat flour for barley, oat, rye and sweet potato flour. Bread with different concentrations of mutamba flour were also evaluated for colour during the storage period (Table 5).

Table 4
Moisture content, weight and volume loss during the storage of the breads.

Parameters	Flour of mutamba (%)	Storage (day)	
		0	5
Moisture content(%)	5	36.15 ± 1.64^{a}	35.99 ± 1.87^{a}
	7	34.86 ± 1.67^{a}	33.77 ± 0.51^{a}
	9	33.91 ± 1.93^{a}	32.26 ± 1.02^{a}
Weight loss (%)	5	–	0.92 ± 0.01
	7	–	0.75 ± 0.01
	9	–	0.71 ± 0.02
Volume (cm^3)	5	2.21 ± 0.01^{a}	2.19 ± 0.01^{a}
	7	2.18 ± 0.02^{a}	2.12 ± 0.02^{a}
	9	2.05 ± 0.01^{a}	2.25 ± 0.02^{a}

Values are expressed as mean ± standard deviation (n = 3). Means with the same letters along the same column are not significantly different ($p > 0.05$).

Table 5
Color parameters of bread with different percentages of mutamba flour during storage.

Storage (days)	Flour of mutamba (%)	Crust color		
		L*	a*	b*
0	5	49.60 ± 0.20^{d}	19.92 ± 0.15^{a}	33.52 ± 0.39^{a}
	7	61.87 ± 0.16^{a}	10.99 ± 0.12^{c}	27.82 ± 0.16^{c}
	9	52.03 ± 0.56^{c}	16.56 ± 0.10^{b}	32.47 ± 0.06^{a}
5	5	49.23 ± 0.05^{d}	17.88 ± 0.06^{b}	33.06 ± 0.07^{a}
	7	58.31 ± 0.20^{b}	11.90 ± 0.04^{c}	28.42 ± 0.21^{c}
	9	48.52 ± 0.57^{d}	17.51 ± 0.20^{b}	30.24 ± 0.47^{b}
Crumbs color				
0	5	65.37 ± 0.23^{a}	7.93 ± 0.13^{a}	23.88 ± 0.20^{a}
	7	61.74 ± 0.57^{b}	7.32 ± 0.06^{a}	22.94 ± 0.10^{a}
	9	58.53 ± 0.11^{c}	7.52 ± 0.05^{a}	22.75 ± 0.13^{a}
5	5	63.73 ± 0.26^{b}	7.33 ± 0.09^{a}	22.83 ± 0.17^{a}
	7	62.80 ± 0.13^{b}	6.60 ± 0.05^{c}	21.12 ± 0.23^{a}
	9	58.59 ± 0.12^{c}	7.08 ± 0.03^{b}	21.42 ± 0.10^{a}

Values are expressed as mean ± standard deviation (n = 3). Means with the same letters along the same column are not significantly different ($p > 0.05$).

The breads showed low luminosity for the crust (L*), the result of the baking process and the addition of mutamba flour, with a typical colour of bread (light brown to dark brown). There was a significant difference ($p < 0.05$) in the L* parameter during storage, which is related to the addition of oats on the surface or by the retrogradation of the starch, with lower luminosity for the samples.

The increase in the concentration of mutamba flour contributed to a gradual increase in the darkening of the bread crumbs, which affected the result of flour colouring (L*: 16.59 ± 0.74, a*: 1.33 ± 0.27 and b*: 21.08 ± 0.40). During storage, there was a significant difference ($p < 0.05$) due to the starch retrogradation process and free water redistribution. Silva et al. (2009) observed that the increase in the percentage of "okara" flour intensified the yellow-brown colour of the crust and the crumbs of the breads, with no significant difference in colour during storage, which is a behaviour different from that found in this study.

3.4.4. Microbiological analysis

All the formulations were in accordance with the legislation (BRASIL, 2001), which recommends maximum values of 10^2 MPN/g for coliforms at 45 °C and absence of *Salmonella* sp in 25 g of samples.

3.4.5. Sensory analysis

For the sensorial analysis, a significant difference ($p < 0.05$) between the formulations with different concentrations of mutamba flour was observed (Table 6).

The formulation with 5% addition of mutamba flour presented a mean for the global acceptance test represented in the structured hedonic scale of nine points between "liked very much" and "like extremely", and the other formulations showed a median between "dislike moderately" and "neither like nor dislike", respectively. Breads added with different concentrations of peel and pulp of baru (*Dipterix alata*

Table 6
Averages of the global acceptability and purchase intention of the tasters for samples of whole wheat bread with mutamba flour.

Attributes	B5%	B7%	B9%
Global acceptability	8.34 ± 1.36[a]	4.83 ± 1.40[b]	3.70 ± 1.45[b]
Purchase intention	4.04 ± 0.94[a]	2.68 ± 0.99[b]	1.42 ± 1.04[b]

Values are expressed as mean ± standard deviation. Means with the same letters along the same line are not significantly different ($p > 0.05$).
Sample 1: Bread with 5% of fruit flour; Sample 2: Bread with 7% of fruit flour; Sample 3: Bread with 9% of fruit flour.

Table 7
Proximate composition of the flour obtained from mutamba fruits and of the bread prepared with the flour in the formulation.

Parameters (g/100 g)	Mutamba flour	Bread
Moisture	10.16 ± 0.38	33.27 ± 1.79
Fat	1.27 ± 0.18	3.48 ± 0.17
Protein	3.18 ± 0.25	9.53 ± 0.42
Crude fiber	26.90 ± 0.37	9.05 ± 0.15
Ashes	2.74 ± 0.11	2.34 ± 0.17
Carbohydrate	55.75 ± 0.11	42.33 ± 0.11
Caloric value(kcal)	247.15	238.76

Mean ± standard deviation (n = 3).

Vog.), native species of Cerrado, presented a mean for the acceptance test between 6.0 and 7.5 ("like slightly" and "like moderately"). According to the authors, the use of this fruit can contribute to the technological application in the elaboration, nutritional and sensorial characteristics of bakery products (Rocha and Santiago, 2009). Hossain et al. (2014) evaluated the development of breads supplemented with jackfruit seed flour and found an average for the overall acceptance test between 6.0 ("Liked slightly") and 7.65 ("Like moderately"), where the lowest addition (25%) did not present any significant difference when compared to the control, with a good overall acceptability. A similar result to that found in this study is that the addition of fruit flour can contribute to the development of new products, such as the addition of Cerrado fruit flour for the development of whole wheat bread with higher nutritional characteristics.

3.4.6. Proximate composition of the flour of mutamba fruits and whole wheat bread

The proximate composition of the flour obtained from the mutamba fruits and the bread containing 5% of this flour are described in Table 7. The flour presented moisture lower than 15%. Additionally, the moisture content of the bread with 5% of mutamba flour is similar to those found in breads with different concentrations of jackfruit seed flour (32.25%–39.87%) (Hossain et al., 2014), different contents of chestnut flour (34.90%–35.30%) (Dall'Asta et al., 2013), cereal-pulse-fruit seed flour (31.36%–39.39%) (Menon et al., 2015), and the use of peel and pulp of baru (32.67%–34.62%) (Rocha and Santiago, 2009). Baking products, such as bread, present a moisture content of around 30% (Esteller and Lannes, 2005), an important parameter that may determine acceptability. However, products with low moisture content may have dry characteristics, and high content may increase water activity and decrease stability during storage.

About the content of fat, protein and ashes of whole wheat bread, these contents may be due to the addition of other ingredients, as the fruit flour showed low content of these parameters in its composition. The mutamba flour presented similar composition when compared to flour obtained from baru for protein content (4.45 ± 0.06%), fat (3.30 ± 0.26%) and ash (1.79 ± 0.01%) (Rocha and Santiago, 2009). Soares-Junior et al. (2010) developed a flour obtained from the external mesocarp of pequi fruit, where the contents of ash (2.86 ± 0.04%) and protein (5.59 ± 0.06%) were found to be greater than the flour of mutamba. However, the carbohydrate content (49.59 ± 0.23%), fat (0.85 ± 0.04%) and moisture (3.08 ± 0.05%) were lower than the present study.

The flour presented high crude fibre content (26.90 ± 0.37%) when compared to baru flour (4.39 ± 0.16%) (Rocha and Santiago, 2009) and jackfruit seed flour (3.09 ± 0.25%) (Hossain et al., 2014) and is similar to that found for native banana pseudo-stem flour (29.92 ± 0.63%). The flour possibly contributed to the crude fibre content of the bread (9.05 ± 0.15%), which is associated with the addition of the other ingredients in the formulation. This behaviour is similar to that observed for bread with higher content of crude fibre when compared to breads made from jackfruit seed flour (2.1%–4.09%) (Hossain et al., 2014), cereal-pulse-fruit seed composite flour (2.1%–2.4%) (Menon et al., 2015), cakes made with passion fruit and orange residues (2.84%–4.95%) (Oliveira et al., 2016) and bread supplemented with banana peels (1.97%–2.18%) (Eshak, 2016).

The caloric value of mutamba flour and bread were 247.24 kcal/100 g and 238.76 kcal/100 g, respectively. The flour presented lower fat and protein content, but with a calorific content slightly higher than bread, which is related to its higher carbohydrate content (55.75 ± 0.11%). The addition of different ingredients in bakery product can contribute to the development of new products with better nutritional and sensorial characteristics than conventional products, such as the addition of fruit meal from the Cerrado or the use of food processing residues.

4. Conclusion

The characterisation of extracts and the development of a product from the *Guazuma ulmifolia* Lam. showed that the potential use and appreciation of fruits are still unexplored. Preliminary phytochemical analysis demonstrated that extracts might be a potential source of bioactive compounds (phenols, steroids, resins, coumarins, quaternary bases, quinones, flavonoids, tannins, saponins and triterpenoids). The toxicity demonstrates the importance of isolating the compounds present in the extract as well as its antioxidant activity evidenced by the qualitative analysis. The flour developed showed low moisture content, water activity and lipids, which are desirable characteristics for this type of product and that contribute to greater stability during storage. The bread had a shelf life of eight to nine days, where the optimal concentration of flour added according to the global acceptance test was 5%, which contributed to a reduction in the caloric value of the developed product. The utilisation of fruits of the Cerrado can be an alternative for greater insertion of the fruits or the by-products obtained from them, which may contribute to a diversified diet and the innovation of ingredients in the development of new products, such as partial replacement of flour in the manufacture of bakery products.

Conflicts of interest

The authors have no conflict of interest to declare.

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