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Physico-chemical characterization of the pulp and peel of Brazilian Pitomba (Talisia esculenta (A. St.-Hill.) Radlk)

Caracterização físico-química da polpa e da casca da pitomba brasileira (Talisia esculenta (A. St.-Hill.) Radlk)

Caracterización fisicoquímica de pulpa y corteza de pitomba brasileña. (Talisia esculenta (A. St.-Hill.) Radlk)

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Layanne Nascimento Fraga
ORCID: https://orcid.org/0000-0003-3208-5048
Universidade de São Paulo, Brasil
E-mail: layanne.net@hotmail.com
Anne Karoline de Souza Oliveira
ORCID: https://orcid.org/0000-0001-8145-0684
Universidade Federal de Sergipe, Brasil
E-mail: karol_olyveira@outlook.com
Bruna Pinheiro Aragão
ORCID: https://orcid.org/0000-0001-8162-3346
Universidade Federal de Sergipe, Brasil
E-mail: bruna.aragao220@gmail.com
Ana Mara de Oliveira e Silva
ORCID: https://orcid.org/0000-0003-0831-8833
Universidade Federal de Sergipe, Brasil
E-mail: anamaraufs@gmail.com
Elma Regina Silva de Andrade Wartha
ORCID: https://orcid.org/0000-0002-7718-1490
Universidade Federal de Sergipe, Brasil
E-mail: ewartha@gmail.com
Leandro Bacci
ORCID: https://orcid.org/0000-0002-8198-6080
Universidade Federal de Sergipe, Brasil
E-mail: bacci.ufs@gmail.com
Luciana Pereira Lobato

ORCID: https://orcid.org/0000-0003-3364-7831
Universidade Federal de Sergipe, Brasil
E-mail: lucianalobato.11@gmail.com
Izabela Maria Montezano de Carvalho
ORCID: https://orcid.org/0000-0002-1680-3137
Universidade Federal de Sergipe, Brasil
E-mail: i.montezano.c@gmail.com

Abstract

This study aimed to evaluate the physico-chemical composition and bioactive compounds of pulp and the peel of the pitomba arising from the state of Sergipe/Brazil. The income, the physico-chemical characterization, mineral content, vitamin C and carotenoids of pulp and pitomba peel were determined. The peel presented high income (44,60% of the fruit). A significant amount of vitamin C (20,68 ± 2,93 mg/100g of fresh sample) and carotenoids (43,56 ± 2,04 µg/mL of the extract) were observed in the pulp, while the peel had a high mineral content, mainly potassium (223,00 ± 2,00 mg/100g), calcium (78,90 ± 0,40 mg/100g) and magnesium (47,50 ± 0,90 mg/100g). The constituents' knowledge of the peel and pulp of the pitomba in natura adds value to the fruit, since it allows a better use of it, considering that the peel is discarded and only its pulp is consumed.

Keywords: *Talisia esculenta*; minerals; carotenoids; vitamin C.

Resumo

Este estudo teve como objetivo avaliar a composição físico-química e os compostos bioativos da polpa e da casca da pitomba provenientes do estado de Sergipe / Brasil. Foram determinados o rendimento, a caracterização físico-química, o conteúdo mineral, vitamina C e os carotenóides da polpa e da casca da pitomba. A casca apresentou um rendimento de 44,60% da fruta. Observou-se uma quantidade significativa de vitamina C (20,68 ± 2,93 mg / 100g de amostra fresca) e carotenóides (43,56 ± 2,04 µg / mL do extrato) na polpa, enquanto a casca apresentou elevado conteúdo de minerais, principalmente de potássio (223,00 ± 2,00 mg / 100g), cálcio (78,90 ± 0,40 mg / 100g) e magnésio (47,50 ± 0,90 mg / 100g). O conhecimento dos constituintes da casca e da polpa da pitomba in natura contribui para agregação de valor ao fruto, uma vez que busca incentivar o seu melhor aproveitamento, considerando que normalmente a casca é descartada, sendo apenas a polpa destinada ao consume humano.

Palavras-chave: *Talisia esculenta*; minerais; carotenoides; vitamina C.

Resumen

Este estudio tuvo como objetivo evaluar la composición fisicoquímica y los compuestos bioactivos de la pulpa y corteza de pitomba del estado de Sergipe / Brasil. Se determinó el rendimiento, la caracterización fisicoquímica, el contenido mineral, la vitamina C y los carotenoides de la pulpa y corteza de pitomba. La cáscara presentó un rendimiento del 44,60% de la fruta. Se observó una cantidad significativa de vitamina C (20,68 ± 2,93 mg / 100 g de muestra fresca) y carotenoides (43,56 ± 2,04 μg / ml del extracto) en la pulpa, mientras que la cáscara presentó un alto contenido de minerales, principalmente potasio (223.00 ± 2.00 mg / 100g), calcio (78.90 ± 0.40 mg / 100g) y magnesio (47.50 ± 0.90 mg / 100g). El conocimiento de los componentes de la cáscara y la pulpa de pitomba in natura contribuye a agregar valor a la fruta, ya que busca fomentar su mejor utilización, teniendo en cuenta que normalmente se descarta la cáscara, siendo solo la pulpa destinada al consumo humano.

Palabras clave: *Talisia esculenta*; minerales; carotenoides; vitamina C.

1. Introduction

There is a growing interest in the study of exotic fruits that are part of the Brazilian culture and are still little explored scientifically. Fruits are important sources of vitamins, minerals, fibers and water, as well as providing nutrients that, when consumed regularly, can act in mechanisms involved in reducing the risks of diseases such as obesity, diabetes, hypertension, dyslipidemia, cardiovascular diseases and some types of cancer (Brasil 2016, Coradin et al. 2011).

As an example of these fruits still little studied there is the Talisia esculenta (A. St.-Hill.) Radlk, whose tree is popularly known as "pitombeira", belong to the Sapindaceae family, whose fruit is the pitomba. The "pitombeiras" are from naturally occurrence in wet and dry woods, both in the Atlantic Forest biome as in areas covered by the Caatinga. Thus, its consumption is predominantly distributed in the North and Northeast regions of Brazil (Santos et al. 2012, Giulietti et al. 2004, Brasil 2018).

The fruiting period is concentrated between the months of January and April, depending on the place of occurrence. There is not yet an organized cultivation of this species, being the fruits collected in backyards or in natural environments, and later used by the population for their own consumption and/or marketed in open fairs, in the streets and in supermarkets, contributing thereby to the small producers' income of the origin regions of origin (Santos et al. 2012, Giulietti et al. 2004, Alves et al. 2009).

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The fruit itself is composed of a small edible mass (pulp), which is very appreciated by the characteristic sweet and sour taste, with the other parts usually being discarded (peel and seed). There are few studies that deal with the composition of the pulp of this fruit and no study, until then, that evaluates the composition of its peel (Santos et al. 2012, Giulietti et al. 2004, Neri-Numa et al. 2014, Freire et al. 2003). In this context, the objective of this work was to evaluate the physicochemical composition of the pulp and peel of the Brazilian pitomba.

2. Methodology

Collection of plant material and sample preparation

The pitombeira fruits were collected on-site in the rural area of Areia Branca city, state of Sergipe/Brazil (10º45'29 "south latitude and 37º18'45" longitude west, altitude of 193,0 meters), in the 2017 harvest in the month of April (Bonfim, Costa and Benvenuti, 2002). The fruits were transported to the Technical and Dietetic Laboratory of the Federal University of Sergipe, where they were sanitized and sanitized with Hidrosteril®, according to the manufacturer's instructions. The husk and pulp were separated manually and stored in a freezer at -20°C.

Physical-chemical characterization

The determination of ash, moisture, proteins, carbohydrates, total soluble solids (TSS), pH and total titratable acidity (TTA) was performed according to the Association of Official Analytical Chemists techniques (AOAC 1995), and lipid content was analyzed according to the methodology described by Bligh and Dyer (Bligh and Dyer 1959). The total energy value (TEV) of the samples was calculated considering the Atwater conversion factors (Merril and Watt 1973).

Minerals Determination

The minerals determination (calcium, zinc, copper, iron, phosphorus, magnesium and potassium) of the pulp and the in natura peel was performed by flame atomic absorption spectrometry in a previously digested sample (AOAC 1998).

Vitamin C

The vitamin C determination of the peel and the pitomba pulp was performed by

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titulometry (AOAC 1998) with 2% oxalic acid solution and titrated with 2,6-dichlorophenol-indophenol solution, previously standardized with ascorbic acid solution (Synth® P.A-A.C.S-99%).

Carotenoids

Carotenoid analysis was performed according to Lichtenthaler (Lichtenthaler 1987), where 2g of fresh sample were homogenized with 0,2 g of calcium carbonate (Impex® P.A-98,7%) and 7 mL of 80% acetone. The mixture was then filtered on filter paper (Unifil® 9 cm diameter) directly into amber volumetric flask and completed to 25 mL with 80% acetone. Absorbance readings were performed in a three-part spectrophotometer (Detection microplate reader Synergy – BIOTEK, Vermont, USA) at 647, 663 and 470 nm, and the concentration was estimated according to the equation

(Eq.1): $$\text{Carotenoids} = \{1000 \times A_{470} - (1{,}82 \times Ca - 104{,}96 \times Cb)\} / 198$$

The concentration of pigments obtained by inserting he absorbance values was expressed in µg/mL of the pulp and peel extract.

Statistical Analysis

All analyzes were performed in triplicate copies. Results were expressed as average ± standard deviation. For the data statistical analysis, was used the t student test ($p<0,05$) using the Graphpad Prism (6.0) software.

Results and discussion

Physical-chemical characterization

Table 1 shows the income in grams and percentage of the whole fruit and the parts that compose it.

Table 1. Proportion of whole fruits of pitomba (Talisia esculenta Radlk) and parts thereof.

Fractions	Mass (g)	Proportion %
Whole fruit	6,30±0,94	100
Peel	2,81±0,14[a]	44,60
Pulp	0,97±0,08[b]	15,40

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Seed	2,52±0,82[a]	40

Results expressed as mean (n = 3) ± standard deviation. Means followed by different letters on the same column differ statistically from one another by Student's T test (p <0.05).

Source: Own Study.

The pitomba pulp presents low income when compared to the peel and the seed. Queiroz et al. (2012) studied lychee (*Litchi chinensis* Sonn), fruit belonging to the same botanical family of pitomba, and found average weight of 18,39±0,44g, of which 4,98±0,21g (27,07%) were peel, 4,05±0,18g (22,02%) were seeds and 9,36±0,24g (50,89%) were pulp. Queiroz et al. (2015) also evaluated the lychee, and verified average of16,36±0,25g, and the fractions have remained similar in both studies, differently from the pitomba income in which the pulp represents the smallest fraction of the fruit (15,40%).

The pitomba pulp presented a high TSS/TTA ratio (Table 2), which allows to suggest that the fruits analyzed had an advanced stage of maturation, since during this process the organic acids contents in most fruits decays, since these are used in the respiratory process, leading to the increase of simple sugars concentration until the complete ripeness (Chitarra and Chitarra 2005, Gobbo and Lopes 2007).

Table 2. Physical-chemical characteristics of pitomba pulp (*Talisia esculenta* Radlk).

Physico-chemical parameters	Pulp
pH	4,20±0,04
Total Soluble Solids-SST (°Brix)	21,33±0,25
Titratable Acidity -ATT (g citric acid/100g)	0,25±0,00
Reason (SST/ATT)	85,32

Results expressed as mean (n = 3) ± standard deviation.

Source: Own Study.

These data are important to identify the fruit maturation stage, as well as its identity and quality standards, providing information of interest to the food industry. Mature fruits have a more pronounced flavor, color and aroma, which can reduce the addition of sugars and preservatives to the products (Chitarra and Chitarra 2005, Gobbo and Lopes 2007).

Andrade (2013) analyzed different rambutan fruit genotypes (*Nephelium lappaceum* L.), fruit already marketed, also belonging to the Sapindaceae family, and the TSS contents found by the authors varied from 7,93 to 19,5 º Brix and the TTA varied from 0,33 to 2,04 mg/100mL.

The results for centesimal composition and total energetic value (TEV) for the peel and the pitomba pulp are presented in Table 3.

Table 3. Centesimal composition (g / 100g) of the peel and pulp of the pitomba (*Talisia esculenta* Radlk).

Parameters	Pulp	Peel
Humidity (g/100g)	80,58±0,10[a]	58,42±0,64[b]
Proteins (g/100g)	2,15±0,08[a]	2,68±0,16[a]
Lipids (g/100g)	0,7±0,01[a]	0,1±0,02[b]
Ashes (g/100g)	0,7±0,04[a]	1,63±0,10[b]
Total Carbohydrate (g/100g)	15,85±0,12[a]	37,15±0,82[b]
VET (Kcal)	78,30±0,31[a]	160,24±2,86[b]

Results expressed as mean (n = 3) ± standard deviation. Means followed by different letters on the same line differ statistically from one another by Student's T test ($p < 0.05$).

Source: Own Study.

The moisture levels, lipids, ashes, pulp and peel carbohydrates differed significantly among themselves ($p<0,05$) and the percentage of proteins was similar among fractions not statistically different ($p>0,05$).

The pulp composition, in this work, is similar to the one obtained by Silva et al. (2008), that analyzed only the pitomba pulp, and found moisture content, proteins, lipids, carbohydrates and ashes of 83,16 ± 0,73 g/100g; 1,15 ± 0,02 g 100g; 0,19 ± 0,01 g 100g; 12,51 ± 0,69 g 100g; 0,61 ± 0,01g 100g of pitomba pulp respectively. Marin et al. (2009) analyzed the pitomba pulp and this one presented total caloric value of 79,1 kcal (g/100g of pulp) and moisture percentage of 78,1±1,1, values that approximate to the present study pulp.

The pitomba peel composition data are similar to the ones obtained by Queiroz et al. (2012), that analyzed the contents of lipids, proteins, ashes and carbohydrates and TEV in the lychee peel, finding 6,97±0,65 g/100g; 10,86±0,26 g/100g; 2,17±0,11 g/100g; 61,11±1,25 g/100g; 107,66±4,26 kcal/100g, respectively.

Table 4 presents the minerals contents (phosphorus, potassium, calcium, magnesium, copper, zinc and iron) of the pitomba peel and pulp.

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Table 4. Mineral contents (mg / 100g) of the peel and pulp of the pitomba (*Talisia esculenta*).

Minerals	Pulp	Peel	Reference values (mg)**
Phosphorus (P)	17,90±0,50[a]	32,30±0,10[b]	700
Potassium (K)	91,90±1,40[a]	223,00±2,00[b]	4700
Calcium (Ca)	23,00±0,52[a]	78,90±0,40[b]	1000
Magnesium (Mg)	16,30±0,15[a]	47,50±0,90[b]	320-420
Copper (Cu)	0,10±0,00[a]	0,44±0,03[b]	0,9
Zinc (Zn)	0,08±0,01[a]	1,21±0,12[b]	8-11
Iron (Fe)	1,55±0,06[a]	2,39±0,04[b]	8-18

Results expressed as mean (n = 2) ± standard deviation. Means followed by diferente letters on the same line differ statistically from one another by Student's T test (p <0.05).

** Reference values according to DRIs (Institute of Medicine, 2000).

Source: Own Study.

The most abundant minerals in these fractions were potassium; calcium and magnesium, being all values found significantly (p<0,05) superior in the peel in relation to the pulp.

The consumption of 100 g of pitomba pulp corresponds to approximately 1,95%; 5,9 % e 2,3 % of the daily recommended ingestion according to the DRIs for an adult individual of the minerals potassium, magnesium and calcium, respectively (Institute of Medicine, 2000). While 100g of peel corresponds to 4,75 %, 14,84%, 7,89%, of the daily recommended ingestion for the same nutrients, respectively.

Silva et al. (2008), analyzing the pitomba pulp minerals contents, found a calcium contents of 26,7 ± 6,35mg/100g, similar to the present study pulp (23 mg/100g).

Wall (2006) analyzed the rambuntan minerals contents of three different regions. The potassium contents varied from 134,5 to 249,4 mg/100g; calcium from 6,8 to 8,7 mg/100g and magnesium from 13,3 to 17,2 mg/100g.

It must be noted that those data add value to the fruit, since its peel composition until then was unknown and it has nutritional potential that in the future can be exploited and used in the elaboration of new products. These nutrients ingestion in adequate quantities is important for the organism good functioning, and the fruits are between the main sources of these minerals. Among other functions, these nutrients act in the substances transport at the immune system as enzymatic cofactors, as it is the case of copper, zinc and magnesium, others in the muscular contraction, blood coagulation, bone formation and maintenance of electrical potential, as calcium and potassium (Martins et al. 2014, Macedo et al. 2010, Pereira er al. 2009, Christimann et al. 2016).

Total carotenoids and vitamin C

In relation to total carotenoids contents and vitamin C (Table 5), the values found in the pitomba pulp were significantly superior to the peel ($p<0,05$).

Table 5. Vitamin C content and total carotenoids of the peel and pulp of *Talisia esculenta*.

Compounds	Pulp	Peel
Vitamin C (mg/100g sample)	200,68±2,93[a]	128,34±5,84[b]
Carotenoides totais (µg/ mL of extract)	343,56±2,04[a]	116,64±3,19b[b]

Results expressed as mean (n = 3) ± standard deviation. Means followed by different letters on the same line differ statistically from one another by Student's T test ($p <0.05$).
Source: Own Study.

Sousa et al. (2012) for the pulp and lychee peel verified vitamin C contents of 24,63 ± 0,70 mg/100g and 0,92 ± 0,07 mg/100g, respectively. Andrade (2008) analyzed the rambutan vitamin C contents from different genotypes, the values obtained varied from 28,61 to 156,06 mg/100mL.

Among the fruits already known by being traditional vitamin C sources are the orange (*Citrus sinensis* (L.) Osbeck) and the Acerola (*Malpighia punicifolia* L.). According to the Brazilian Table of food composition (TACO 2011), the vitamin C contents for the orange is 53,7 mg/100g (edible part) and the acerola is 941,4 mg/100g (edible part).

Pursuant the DRIs, the daily vitamin C need for an adult corresponds to 75 mg/day (Institute of medicine 2000), and, in this way, approximately 37,37 mg of pitomba pulp provides the daily necessary quantity of vitamin C, according to DRIs for this nutrient.

In agreement with Rodrigues-Amaya, Kimura and Amaya-Farfan (2008), the buriti pulp contains high quantity of these compounds. Manhaes and Sabaa-Srur (2011) in their study evaluated the buriti (*Mauritia flexuosa*) pulp, and the total carotenoids quantity was 23,36 ± 0,98 mg/100g.

Vitamin C and carotenoids are linked to a decreased risk of various diseases. Among other functions, the first one acts in the collagen synthesis and improves the immune system

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and the second one acts in the prevention of the occurrence of cataract and as natural dyes of interest to the food industry. It is noteworthy that both compounds act as natural antioxidants, and have the ability to hijack reactive oxygen species, thus protecting cells from oxidative damage (Couto and Canniatti-Brazaca 2010, Galani et al. 2017).

It is valid to emphasize that the differences between the found results in the present study and the papers searched in literature may be caused by various factors, between these, it must be considered that such characteristics vary between different fruits, according to the cultivation, climatic conditions and growing region, and also for being applicated different methodologies in the studies in question for the same analysis (Andrade 2008, Galani et al. 2017, Denardin 2015).

Conclusion and perspectives

The pitomba pulp and peel represent an expressive source of vitamin C and carotenoids, being the pulp of greater prominence for these nutrients. The peel presented high minerals contents such as potassium, calcium and magnesium. Data on this fruit composition are crucial, once data on the chemical constitution of exotic Brazilian native foods are limited. In this way, the knowledge of the constituents of the pitomba peel and pulp, *in natura*, adds value to the fruit, since it makes possible a better use of it, considering that the peel is discarded and only its pulp is consumed. Nevertheless, it is necessary to carry out new studies that report its antinutritional factors, potential toxicity and biological properties.

Compliance with Ethical Standards

The authors declare compliance with ethical standards.

Conflict of interests

The authors declare no conflicts of interest.

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Porcentagem de contribuição de cada autor no manuscrito

Layanne Nascimento Fraga – 30%

Anne Karoline de Souza Oliveira – 10%

Bruna Pinheiro Aragão – 10%

Ana Mara de Oliveira e Silva – 10%

Elma Regina Silva de Andrade Wartha – 10%

Leandro Bacci – 10%

Luciana Pereira Lobato – 10%

Izabela Maria Montezano de Carvalho – 10%