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Physical, Chemical-Physical Characterization and Determination of Bioactives Compounds of the Pimtobeira Fruits (*Talisia esculenta*)

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Abstract

Pitombeira fruits have characteristics that provide them with industrial and processed consumption, but they are barely studied, resulting in the need to obtain more information about the species' potential and its utilization to various purposes. In face of these facts, a physical, chemical-physical and a determination of bioactive compounds post-harvest characterization of pitombeira fruits was done. The fruits were acquired in a street Market in the municipality of Sousa-PB, Brazil, and taken to the Food Analysis Laboratory of the Center of the Federal University of Campina Grande, in the municipality of Pombal-PB, Brazil. Fruits were selected by the absence of physical damage and diseases, as well as by their ripening stage and size, and refrigerated at 4 ºC. Gone 15 repetitions with 25 fruits, 20 fruits were destined to chemical-physical and determination of bioactive compounds analysis and the 5 remaining fruits to the physical analysis. Pitombeira fruits had ideal functional characteristics and necessary to the development and processing of new products, such as high protein content (31.72% in the seed and 39.72% in the skin), phenolic compounds (101.47% in the seed and 106.61% in the skin) and carotenoids (10.14% in the seed and 23.39% in the seed husk). In particular, Pitomba's pulp can be used for in natura consumption as well as processed, since it has high contents of mineral residue, soluble solids and vitamin C. Pitomba fruits have excellent physical, chemical-physcial and bioactive compounds characteristics, as observed in the high contents of proteins, phenolic compounds, carotenoids and flavonoids in all parts of the fruit. With all these characteristics presented, products such as juices, beverages, bakery products and even food supplements can be made form the pitomba.

Keywords: pitomba, ascorbic acid, quality

1. Introduction

In recent years, interest in native fruit species has increased considerably, both by researchers and consumers more concerned about lifestyle and healthy eating habits. Several studies that fruits, in addition to nourishing, contain substances that can health benefits, such benefits being attributed to the presence of bioactive compounds, many with antioxidant action, effective in protecting against chronic diseases, such as cardiovascular diseases and cancer (Alu'datt et al., 2017; Celant et al., 2015; Virgolin et al. 2017). The Brazilian native fruits are among the most tasty and nutritious in the world, however, many of them are only known by the local population or appear seasonally in some specific regions (Ferreira et al., 2005). In the Caatinga, although many species have fruits that are used as food, the native fruit trees that occur in the Northeast are still known scientifically (Éder-Silva, 2006). The pitombeira (*Talisia esculenta* Radlk), from Sapindaceae family, is a species native to the Amazon region, being found in the interior of primary dense forests, as well as in formations but always in alluvial floodplains and deep of valleys, mainly in transition areas of Cerrado and Caatinga, in the North, Northeast and Southeast of Brazil (Guarim Neto et al., 2003). Still second the authors, the fruits are almost globose, granulated, appressed and slightly pubescent, powdery, yellowish and with residues of the chalice, usually monospérmicos. The seeds are elongated, with reddish brows just after the fruit has been removed and dark when dry, surrounded by whitish pink aryl and edible.

The pitombeira (*Talisia esculenta* Radlk.) Is a very native fruit however, there is a lack of studies on its propagation and its nutritional characteristics. Native species should have preference over exotic ones, since the valuation of native plants is essential for biodiversity. Another factor is that native plants are less susceptible to insects or diseases (Rodrigues et al., 2007). In view of these facts, the purpose of the research was to perform a physical, physicochemical and bioactive characterization of all parts of the pitomba to find out if it had nutritional potential for use as raw material in the processing of new food products.

2. Material and Methods

2.1 Acquisition and Selection of Fruits

Pitomba fruits were bought in a street market in the city of Sousa-PB, Brazil, and were later taken to the Food Analysis Laboratory of the Agrifood Science and Technology Center of the Federal University of Campina Grande, in the municipality of Pombal-PB, Brazil, in a proper car, stored in cardboard boxes at room temperature.

At the moment of purchase, the pitombas were selected by the size of the bunch, maturation stage and individual fruit size. In the laboratory, they were selected by absence of physical damage, diseases and maturation stage, observed through its color and physical state of the fruit after seeing their internal parts and size.

2.2 Experimental Design

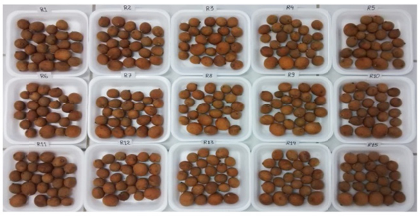
For the chemical and physical analysis a completely randomized design was used, in a total of 15 repetitions, with each experimental unit containing 150 g of fruits, 25 fruits on average. In each repetition, 20 fruits (110 g) were destined to chemical and functional analysis and 5 fruits (40 g) to physical analysis, totaling 75 fruits to the physical analysis and 300 fruits to the chemical and functional analysis.

QUEIROGA, 2015 QUEIROGA, 2015 QUEIROGA, 2015

Figure 1. Reception, selection and preparing of the pitombeira fruits to assemble the experimental design. CCTA/UFCG, Pombal, PB, 2015

OUEIROGA. 2015.

1st Step: Weighing of total fresh mass and of fresh mass by repetition.



QUEIROGA, 2015.

OUEIROGA. 2015.

Random choice of 5 fruits by repetition to physical analysis.

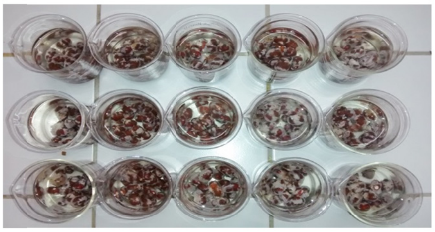
OUEIROGA. 2015.

OUEIROGA. 2015.

2nd Step: Weighing and transversal and longitudinal diameter measurement of the fruits.

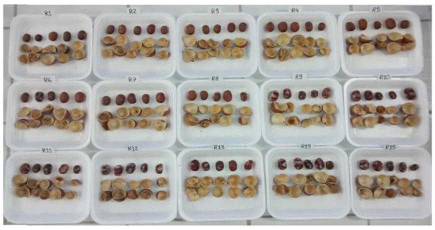
OUEIROGA. 2015.

OUEIROGA. 2015.



QUEIROGA, 2015.

Removal of seed husk.



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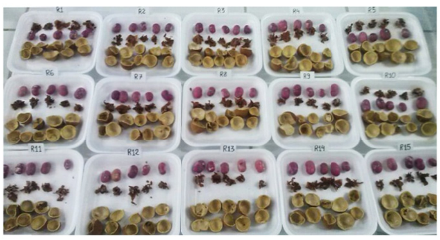

OUEIROGA. 2015.

Cold storage at 4°C to chemical-physicall and determination os bioactive compounds analysis of the whole fruit.

OUEIROGA. 2015.

Figure 2. Preentation of the procedures of experimental assembling

2.3 Physical Analysis

Physical analysis was represented by 5 fruits of each one of the 15 repetitions. They were done right after the fruits' selection, firstly utilizing them whole with subsequent pulping and seed husk removal to continue the other parts of the fruit analysis.

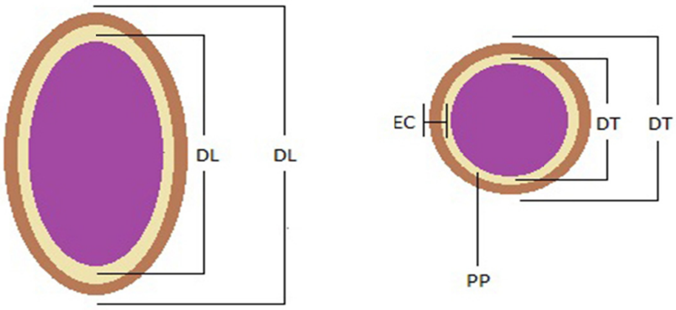

Figure 3. Longitudinal and transversal diameters, shell thickness and pulp weigh.
CCTA/UFCG, Pombal, PB, 2015

Diameters and thickness: Diameters and thickness were measured with the aid of a digital paquimeter and the results were expressed in milimiters (mm).

- Longitudinal and transversal diameter of the fruit with the shell;
- Longitudinal and transversal diameter of the shelled fruit with the pulp;
- Longitudinal and transversal diameter of the seed;
- Shell thickness in two opposite sides.

Fresh mass: Were determined utilizing a semianalytic scale with precision of 0.01 g, and the results were expressed in grams (g).

- Total fresh mass;
- Fresh mass through repetition;
- Mass of the fruit with the shell;
- Mass of the shelled fruit;
- Mass of the shells;
- Mass of the pulp;
- Mass of the seed without the pulp;
- Mass of the individual seed husk;
- Mass of the huskless seed.

2.4 Chemical and Functional Analysis

Moisture (%): was determined through drying in a heating chamber at 105 °C until constant weight in accordance to the analytic methods of Instituto Adolfo Lutz (2008).

Ashes (%): were determined by incinerating the sample in a furnace at 550 °C until the ashes were White or slightly grayish according to Instituto Adolfo Lutz (2008).

Protein (%): the total nitrogen content of the samples was assessed by Kjeldahl Method, through a titration with NaOH and utilizing the generic conversion factor 5.9 to transform the quantified content in protein, according to the method described by Instituto Adolfo Lutz (2008).

pH: was determined through direct Reading in a digital potentiometer, in accordance to Instituto Adolfo Lutz (2008).

Titratable acidity (%): was determined through titration of the samples against a sodium hydroxide solution at 0,1M until pH 8.1. Results were expressed in percentage of citric acid, according to Instituto Adolfo Lutz (2008).

Soluble solids (%): juice was extracted with the aid of a 30 mesh stainless steel sieve, and later the extract was transferred with the aid of cotton to Reading in a digital refractometer with automatic temperature compensation and the results were expressed in percentage.

Total soluble sugars (%): were determined through Anthrone Method according to Yemm and Willis (1954), through mixture of 1.0 mL of pitomba extract in water with 2.0 mL de anthrone made in an ice bath, followed by agitation and rest in a water bath at 100 °C for 3 minutes. Glucose was used as a reference to the acquisition of the standard curve and the Reading was done in a spectrophotometer at 620 nm with results expressed in g/100 g.

Total phenolic compounds (mg/100 g): were estimated from the Folin-Ciocalteau method, as described by Waterhouse (2006) through the mixture of 2125 µL of pitomba extract dilluted in water and 125 µL of the Folin-Ciocalteau reagent, followed by agitation and rest for 5 minutes. Right after the reaction time 250 µL sodium carbonate was added, followed by new agitation and rest in a water bath at 40 °C, for 30 minutes. The standard curve was prepared with galic acid and the readings were done in a spectrophotometer at 765 nm and the results were expressed in galic acid mg/100 g.

Ascorbic acid (mg/mL): the contente of ascorbic acid was determined with Tillmans method, through the titration of the sample against a solution of 2.6 dichlorophenol indophenol, according to methodology described by Carvalho et al. (1990). Results were expressed in ascorbic acid mg/100 g.

Carotenoids (mg/100 g): 0.5 g of the sample was weighted with 0.2 g of calcium carbonate to be extracted in cold 80% acetone, after intense maceration it was centrifuged and filtered through 0.45 µm paper filters and quantified through spectrophotometry, were the readings were done in a spectrophotometer at wavelegth of 460nm with the results expressed in mg/100 g as described by Lichtenthaler (1987).

Flavonoids & Anthocyanins (mg/100 g): were determined according to Francis (1982) methodology.To flavonoids and anthocyanins 0.5 g of the sample was weighted and macerated in a mortar to extraction in a ethanol-HCl 80% solution and left to rest for 24 hours. Readings were done in a spectrophotometer at 374 nm and 535 nm with results expressed in mg/100 g.

2.5 Statistical Analysis

Data obtained was subject to variance analysis by the F test and the means were compared by Tukey test at 5% probability level. The data correlation was done by the Assistat software, version 7.7 beta (Silva, 2014).

3. Results and Discussion

According to Table 1 it was possible to observe that, in average, a whole pitomba weighed 8.22 g. Individually, the heaviest part of the fruit was the pulp, with 3.29 g, followed by the seed, with 3.09 g, and finally the shell with 1.91 g. In relation to other fruits, the pulp yield of pitomba fruit was low, showing a value of 39%, under 50% and way under the average values obtained by Brunini et al. (2004), Lira et al. (2005), Lima et al. (2002), that observed respectively, 65% in *acerola*, 82% in *cajá-umbu* and 53% in *umbus-cajazeiras*.

Table 1. Average mass and yield of pitombas in their whole form and divided by parts. (CCTA/UFCG, Pombal-PB, 2015)

Part of the Fruit	Weight (g)	Yield (%)
Whole fruit	8.22±2.43	100
Shelled fruit	6.32±1.71	76.76
Shell	1.91±0.79	23.24
Pulp	3.29±1.06	39.16
Seed	3.09±0.90	37.60
Husk less seed	2.87±0.84	35.05
Individual husk	0.21±0.08	2.55

According to Guarim Neto (2003) pitombas are small rounded drupes with a big and oblong (longer than broader). Physical analysis corresponding tolongitudinal and transversal diameter proved these data through the results obtained in the measurements of the whole fruit, of the shelled fruit and of the seed (Table 2). To the whole fruit the longitudinal diameter of 26.97 mm was larger than the transversal diameter of 23.32 mm. The same happened in the shelled fruit with 25.67 mm to longitudinal and 21.98 mm to the transversal and in the seed with 21.27 mm to the longitudinal and 12.94 mm to transversal.

Table 2. Longitudinal and transversal diameter and shell thickness in whole pitombas and pitombas divided by parts. (CCTA/UFCG, Pombal-PB, 2015)

Part of the fruit	Longitudinal diameter (mm)	Transversal diameter (mm)
Whole fruit	26.97±2.83	23.32±2.32
Shelled fruit	25.67±2.70	21.98±2.18
Seed	21.27±2.03	12.94±1.58
Part of the fruit	**Shell Thickness (top) (mm)**	**Shell Thickness (middle) (mm)**
Shell	1.34±0.29	1.29±0.26

Table 3 highlights the moisture, ashes and protein contents referring to the physical-chemical characterization of the pitomba fruits and some fruits of the cerrado. Moisture found in pitomba was higher than 80%, value similar to the ones found by Silva et al. (2008), in the characterization of the cerrado fruits with expetion of the *macaúba* and of the *chichá* that obtained the lowest moisture values. However, in the *chichá* the edible part is classified as a seed and not as pulp, reducing considerably its moisture content. Pitomba had fixed mineral residues, the contents of 1.18% obtained showed a high percentage when compared to the ones found by Silva et al. (2008) with contents of 3.82% to *chichá*, 1.78% in *macaúba*, 0.33% to *araçá and caju do cerrado*, 0.58% to *mangaba* e 0.78% to *murici*. The percentage of proteins was very high and relatively higher when compared to other fruits analysed by Silva et al. (2008), showing a great potential for consumption and possibly in the industrial utilization, being inferior only to chichá that has around 19% of proteins.

Table 3. Moisture, fixed mineral residue and proteins in pitomba and other fruits pulp (CCTA/UFCG, Pombal-PB, 2015)

Fruit	Moisture (%)	Fixed Mineral Residue (%)	Proteins (%)	Source
Pitomba	80.73±1.23	1.18±0.46	8.24±0.49	QUEIROGA, 2015
Araçá	82.36±0.09	0.33±0.01	0.50±0.05	SILVA, 2008
Caju-do-cerrado	86.57±0.11	0.33±0.01	1.18±0.02	
Chicha	6.95±0.02	3.82±0.04	19.58±0.80	
Macaúba	34.32±0.13	1.78±0.02	2.76±0.21	
Mangaba	82.40±0.09	0.58±0.02	1.20±0.04	
Murici	80.64±0.08	0.78±0.02	0.72±0.05	

To pitomba the acidity value of 1.25% (Table 4), shows low acidity fruits, since it was inferior to buriti with 1.48% and acerola with 1.90%, however superior to murici with 1.00%. According to Sousa et al. (2013), acidity is an important parameter in the appreciation of the conservation state of a food. The observed pH of 3.73 to the pitomba pulp was superior to the values verified to the *buriti, murici* and *acerola* with values of 3.47, 3.70 e 2.80, thus showing that pitomba is less acid than those. The verified soluble solid content of 19.02% was higher than the values observed by Canuto et al. (2010) in *murici* and in *acerola* and by Castro et al. (2014) in *buriti*, that were of 1.50%, 3.50 and 13.67% respectively. According to Silva et al. (2012), the soluble solids content shows correlation to sugar levels and organic acids, a characteristic of interest in products sold *in natura*, for the consumer Market prefers sweet fruits. Pitomba showed an elevated value of vitamin C in its pulp when compared to the values obtained by Cardoso (2011) in *pequi, jatobá* and *acerola*.

Table 4. Titratable acidity, pH, soluble solids and vitamin C in pitomba pulp and cerrado fruits. (CCTA/UFCG, Pombal-PB, 2015)

Fruit	Titratable acidity (%)	pH	SS (°Brix)	Vitamin C (mg/mL)	Source
Pitomba	1.25±0.12	3.73±0.14	19.02±0.01	18.60±5.44	QUEIROGA, 2015
Buriti	1.48±0.02	3.47±0.01	13.67±0.58	-	CASTRO, 2014
Murici	1.00±0.01	3.70±0.20	1.50±0.01	-	CANUTO, 2010
Acerola	1.90±0.01	2.80±0.40	3.50±2.10	-	CANUTO, 2010
PEQUI	-	-	-	14.33±0.32	CARDOSO, 2011
Jatobá	-	-	-	8.91±1.86	CARDOSO, 2011
Araticum	-	-	-	5.23±7.19	CARDOSO, 2011
Wild plum	4.59±5.09	2.6±11.17	24.35±6.26	21.51±8.73	SILVA, 2008

According to the Tukey test at a 5% probability level it's noted that there was a significant difference in all characteristics analyzed in the pulp, shell, seed and seed husk of the pitombeira's fruit, except for anthocyanins where there was no difference (Table 5).

Values expressed for proteins in the shell, the seed and the husk were excellent and of great relevance, way superior to all fruits studied by Silva et al. (2008) that were *Araçá* (0.50%), *Caju-do-cerrado* (1.18%), *Chichá* (19.58%), *Macaúba* (2.76%), *Mangaba* (1.20%), *Murici* (0.72%).

Pitomba has more bioactive compounds than the compared fruits. The values of phenolic compounds were of 84.77mg/100 g in the pulp, 106,61 mg/100 g in the shell e 101.47 mg/100 g in the seed showing that pitomba has a lower antioxidant capacity than the fruits studied by Rocha et al. (2011) that were *Cagaita* (111.00 mg/100 g), *Gabiroba* (270,00 mg/100 g) and *Pitanga do cerrado* (225.00 mg/100 g), due to the fact that the contents being way above those.

Pitomba showed low total sugar content in the pulp (2.91%), shell (3.19%) and seed (1.95%), results lower than those of cashew (36.55%), guava (5.31%) and passion fruit (8.30%) found by et al. (2008) and to the values found by Fernandes et al. (2001), regarding *arabica* coffee grains (9.59%) and canilon (4.95%). Verified results for carotenoids in the pulp (6.60 mg/100 g), seed (9.66 mg/100 g) and seed husk (23.39 mg/100 g) were expressive when compared to the values found by Cardoso (2011) in *Araticum* (4.98 mg/100 g), *Cagaita* (0.77 mg/100 g), *Jatobá* (0.39 mg/100 g) and *Mangaba* (0.12 mg/100 g).

In flavonoids, it was found (2.50 mg/100 g) in the seed and (8.95 mg/100 g) in the seed husk and for anthocyanins (1.51 mg/100 g) in the seed and (1.47 mg/100 g) in the seed husk. As for the flavonoids, the seed results were inferior to all found by Rocha et al. (2013) in *Chichá* (2.81 mg/100 g), *Cajuí* (2.81 mg/100 g), *Macaúba* (4.56 mg/100 g) and the ones in the husk were superior to the same ones. As for the anthocyanins, the values obtained in the seed and in the seed husk were far superior to those of the *Chichá* (0.88 mg/100 g), *Cajuí* (0.22 mg/100 g), *Macaúba* (0.52 mg/100 g).

Table 5. Carotenoids, flavonoids, anthocyanins, soluble sugars, phenolic compounds and proteins in the pulp, shell, seed and seed husk of pitomba. (CCTA/UFCG, Pombal-PB, 2015)

Parts of the fruit	Protein (%)	Phenolic c. (mg/100 g)	Soluble sugar (%)	Carotenoid (mg/100 g)	Flavonoids (mg/100 g)	Anthocyanins (mg/100 g)
Pulp	8.24±0.49d	84.77±14.34b	2.91±0.03b	6.61±3.49c	-	-
Seed	29.94±1.06b	101.47±12.32a	2.95±0.03b	10.14±2.67b	2.50±0.83b	1.51±0.48a
Shell	37.50±2.50a	106.61±6.87a	3.19±0.14a	-	-	-
Seed husk	24.99±1.81c	-	-	23.39±3.75a	8.95±0.95a	1.47±0.39a

Note. Means followed by the same lowercase letter in the column didn't differ between them, according to the Tukey Test at 5% probability level.

4. Conclusions

Pitomba pulp can be put to good use, for either *in natura* or processed, since it showed high contents of mineral residue, soluble solids and vitamin C.

Pitombeira has excellent physical, chemical-physical characteristics and bioactives compounds, as observed in the high contents of proteins, phenolic compounds, carotenoids and flavonoids in all parts of the fruit.

Values obtained for proteins in the shell, the seed and the seed's husk were excellent and of great relevance, what makes the usage these respective parts to various industrial and consumption ends.

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