Evaluation of physical and chemical parameters of the Sapota (Quararibea cordata Vischer): A fruit of the Amazon Brazilian

Avaliação dos parâmetros físicos e químicos da Sapota (Quararibea cordata Visher): uma fruta da Amazônia Brasileira

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ABSTRACT – Sapote (*Quararibea cordata* Vischer), also known as a *chupa-chupa*, is originated from the Brazilian, Peruvian and Colombian Amazon. The pulp of the ripe fruit is edible, fibrous, of intense orange color, sweet flavor and aromatic. Since the fruit is known in the Brazilian Amazon only in its domesticated state, this work becomes necessary, which evaluates the physical and chemical profile of the fruit and provides more information about its industrial potential. The following parameters were assessed: total mass (g) longitudinal and transversal diameters (mm), proximal composition, caloric value, carotenoids, total pectin, total titratable acidity, pH, total soluble sugars, organic acids, color, antioxidant potential and phenolic compounds. The Sapote grown in Goiânia has average mass of 595 g, longitudinal diameter of 10.06 cm and transversal diameter of 10.6 8 cm. The fruit contains large amounts of dietary fiber (11.94%) and carotenoids (1.91 $\mu g.g^{-1}$), and high total pectin content (5.24%). The fruit also has phenolic compounds in the alcoholic extracts of 6.31 $mgGAE.100g^{-1}$ and 15.06 $mgGAE.100g^{-1}$ in the aqueous extract. This makes the fruit to have a functional feature. Thus, it can be included in the industrial context, with the main feature of being an exotic fruit with properties that give it good nutritional performance.

Keywords: Dietary fiber, Carotenoids, Total pectin.

RESUMO – A Sapota (*Quararibea cordata* Vischer), também conhecida como chupa-chupa, é originária da Amazônia Brasileira, peruana e colombiana. A polpa do fruto maduro é comestível, fibrosa, de cor alaranjada intensa, sabor doce e aromática. Por ser pouco conhecida, torna-se necessário este trabalho, com o objetivo de avaliar o perfil físico e químico do fruto e, assim, obter mais informações sobre o seu potencial industrial. Foram avaliados: massa total (g), diâmetros longitudinal e transversal (mm), além da composição centesimal, valor calórico, teor de carotenóides, pectina total, acidez titulável total, pH, teor de açúcares solúveis totais, ácidos orgânicos, cor, potencial antioxidante e compostos fenólicos. Verificou-se que a sapota em Goiânia possui massa média de 595 g, diâmetro longitudinal de 10.06 cm e transversal de 10.68 cm. A fruta possui grandes quantidades de fibras alimentares (11.94%) e carotenóides totais (1.91 $\mu g.g^{-1}$), além de um elevado teor de pectina total (5.24%). O fruto tem ainda uma quantidade de compostos fenólicos no extrato alcoólico de 6.31 $mgEAG.100g^{-1}$ e de 15.06 $mgEAG.100g^{-1}$ no extrato aquoso. Isso faz com que esse fruto tenha um caráter funcional. Dessa forma, pode ser inserido no cenário industrial, tendo como principal característica ser um fruto exótico com propriedades que lhe garantem um bom desempenho nutricional.

Palavras-chave: Fibra alimentar, Carotenóides, Pectina total.

INTRODUCTION

Sapote (*Quararibea cordata* Vischer) is originated from the Peruvian and Colombian Amazon and known only in the Brazilian Amazon in its domesticated state , i.e., it is very appreciated by Indigenous populations. The tree can grow up to 12 - 15 m tall, the fruit is globular or ovoid, 7 to 15 cm wide, 5 to 15 cm in diameter, its rindsis greenish brown and has four or five cuneiform seeds (Braga et al., 2003).

The cream-colored flowers appear at random among the smaller branches. About eight months after flowering, the fruits become ripe. Fruiting occurs between the months of February and March, and the fruits appear on the branches, firmly linked by a small trunk (Carvalho et al. 2012).

The pulp of the ripe fruit is edible, fibrous, of intense orange color, sweet flavor and aromatic and with great industrial potential. Known in Colombia as common Sapote, its distribution also includes Brazil, Peru, Ecuador and Venezuela. In Colombia, it is found in the valleys of the Cauca and Magdalena rivers, with a thick rind similar to apricot (*Mammea americana*). The pulp, is the edible part, used for *in natura* consumption or in the form of juice; however, it is possible to prepare compote with the inner part of the rind. It has a very sweet taste and, when eaten for the first time, its taste resembles the taste of fruits like mango and papaya (BRAGA *et al.*, 2003).

Studies conducted in the Napo river region

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(Brazil) showed that Sapote, along with other species, is used in the feeding of indigenous communities of the region, being cataloged in this study as juicy plants (ALEGRÍA *et al.*, 2007). Physiochemical analyses of the pulp and rind revealed that it represents, on average, 12.06% of total soluble solids, 0.064% of total titratable acidity, 84.04% of moisture, 6.92% of protein, 1.38 % of fat, 4.28% of ash, 3.66% of carbohydrates and 1612.53 IU of vitamin A (BRAGA *et al.*, 2003).

Considering that Sapote is little known in the national and international the characterization of the fruit is important to assess its potential, very little is known about its physical, chemical characteristics and industrial potential.

Thus, the aim of this study was to evaluate the physical and chemical profile of Sapote pulp (*Quararibea cordata* Vischer).

MATERIAL AND METHODS

Material

Raw material (Sapote) was obtained in the region of Goiânia, Brazil, in March 2011. About 50 fruits were collected randomly from different trees in the region of Goiânia. Because they are non-climacteric fruit, sapota was harvested in the maturity stage ready for consumption.

Physical analysis

The 50 fruits were measured with a caliper to obtain the height and diameter of each fruit. The whole fruits were weighed, shelled and separated from the seed. Fruit pulp and rind were weighed (mass). The rind thickness was measured with a caliper. The objective color was measured directly with a Minolta colorimeter CR-400, in mode CIE L * a * b *. The readings were taken at six points. The results were expressed as the mean values with their standard deviation and variation coefficient.

Analysis of proximal composition

Be performed after measures of weight and length, the fruits were peeled with stainless steel cutting material and separate the pulp from the rind and seeds. Pulp was then homogenized and evaluated for chemical analysis described below.

The moisture content was determined by weight loss of product submitted to heat at 105°C, according to AOAC standards (2006) and the results expressed in percentages. The ash content was determined by calcination of the fresh fruit at a temperature of 550°C until complete combustion, according to AOAC (2006). The protein content was determined through the Kjeldahl method according to AOAC (2006), where the value was multiplied by 6.25 and the results expressed in percentages. The total lipid content was determined by the method of Bligh & Dyer (1959). The total carbohydrate content determination followed methodology of sulfuric phenol, according to Dubois et al. (1956), and the results were expressed in percentage and the total caloric value was estimated according to the Atwater conversion values and the results expressed in Kcal.

Chemical analysis

The content of reducing sugars was also determined using the 3,5-dinitrosalicylic acid method (ADNS), with modifications presented by Silva et al. (2003). The soluble solids content was determined using a benchtop refractometer Shimadzu (AOAC 2006) and the result expressed in Brix degree. The pH was determined by digital potentiometer Micronal B222, introducing the electrode directly into the fruit (AOAC 2006). The total titratable acidity was determined by titration with 0.1 N NaOH, AOAC (2006). The carotenoids determination was carried out by extracting by grinding the pulp with petroleum ether and acetone (1:3). Quantification was obtained by spectrophotometry with absorbance reading in the range of 450 nm and the vitamin A content was given in $\mu g.g^{-1}$ of carotenoids, according to Rodriguéz-Amaya (1997). Measurement of total and soluble pectin was performed using the colorimetric method, based on product formation through colorful condensation obtained by reaction of hydrolyzed pectin (galacturonic acid) with carbazole (Bitter & Muir 1962) and the results expressed in percentage.

The extraction of aqueous and alcoholic extracts was performed according to Genovese *et al.* (2003) for determination of total phenols with the Folin-Ciocalteu reagent and the results expressed in $mgGAE.100g^{-1}$. All tests were performed with fifteen (15) replicates of a homogeneous batch of fifty (50) fruits, being randomly selected, and the results were expressed as average values with their standard deviation.

RESULTS AND DISCUSSION

Physical analysis of fruits

The visual assessment of the ripe fruits (Fig. 01) showed that they have thick and resistant rind, with greenish-brown color and powdery, and the pulp is orange, fibrous and juicy, containing four to five cuneiform seeds, and about 85% of fruits have 5 seeds and the remaining 4 seeds, which is consistent with the findings by Shanley & Medina (2005), studying Sapote from the Brazilian Amazon region.

The whole fruits had an average mass (Table 1) equivalent to that found by Braga et al. (2003), who obtained data that ranged from 373g (minimum value) to 1088g (maximum value), studying Sapote from the Tefé region (Brazil), but lower than that found by the Brazilian Entity of Farming and Cattle Raising (EMBRAPA, 2005), whose average weight found was 882.4 g. In both studies, the fruits were obtained from the Brazilian Amazon region, which is the region of its natural occurrence, and different from species analyzed in this study, which were obtained from the mid-western region of Brazil.

Therefore, it is evident that the best development is in the region of natural occurrence, because the climatic and soil conditions are crucial for such features. While the average weight of the rind and seed represent 49% and 7,2%, respectively, Braga et al. (2003) found 61.8% and 5%, respectively. The transversal and longitudinal diameters are also in agreement with values found by Braga et al. (2003), who found average values of 10.95 cm and 10.85 cm, respectively. EMBRAPA (2005) found average values of 12.9 cm and 11.8 cm, being slightly higher than the fruits of this study. The determination of coordinates L *, a *, b * characterizes the pulp color. On this scale, L * means how clear or how dark is the fruit, ranging from zero (black) to 100 (pure white); of a * and b * values represent hue and saturation levels, with + a (indicating red), - a (indicating green) + b (indicating yellow) and - b (indicating blue). Positive a * b * values, as those observed in this study, are attributed to the presence of carotenoids in the pulp. Similar results were found by Jha et al. (2012) in apple, while Ribeiro et al. (2007) found values to the L* value ranged from 59.1 to 61,3; a * value ranged from 11.5 to 14.4 and b * value ranged from 39.6 to 49.7.

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Figure 1. Sapote fruits (*Quararibea cordata* Vischer) obtained in the region of Goiânia, Brazil

Table 1. Averages of physical analysis of Sapote fruit (*Quararibea cordata* Vischer), obtained in the region of Goiânia, Brazil.

Analyses	Mean (sd)
Total weight (g)	595,23 (10,05)
Rind weight (g)	292,51 (9,42)
Seed weight (g)	42,92 (1,41)
Transversal diameter (cm)	10,68 (0,76)
Longitudinal diameter (cm)	10,06 (0,61)
Rind thickness (mm)	0,9 (0,26)
L* Value	44,90 (0,11)
a* Value	18,27 (0,19)
b* Value	43,06 (0,51)

Results are reported as means ± standard deviation (sd), (n=50).

Analysis of proximal composition

As for the proximal composition (Table 2), Sapote pulp is quite diversified. It showed moisture of 90.75%, a value close to that found by Alegría et al. (2007), who studied two varieties of the fruit, namely variety Caucana and variety Equatoriana, both from the Colombian Amazon.

In the variety Caucana, a value of 87.15% for moisture was found, while in the variety Equatoriana, a value of 87.44% was obtained. Aguiar (1996) found a value of 82.5% for the moisture content in fruits from the Brazilian Amazon, being a little farther from the value found. Thus, it was observed that Sapote is a fruit with a relatively high humidity and thus its consumption, after ripening, should be fast because high humidity promotes fast deterioration. This suggests the potential of the fruit for industrialization, since its perishability is high. Thus, the processing of fruit in the preparation of jams, juices and nectars is essential for its conservation and availability for domestic and international markets.

Table 2. Proximal composition of Sapote pulp obtained in the region of Goiânia, Brazil

Analyses	Mean (sd)
Moisture (%)	90,75 (1,76)
Ash (%)	0,29 (0,01)
Protein (%)	0,54 (0,14)
Lipid (%)	0,18 (0,00)
Carbohydrate (%)	8,24 (0,03)
Caloric value (Kcal)	36,74 (0,16)

Results are reported as means ± standard deviation (sd) and are expressed in fresh weight basis (n=15).

The results obtained allow concluding that the caloric value was 25.06 Kcal for an intake of 100g of fruit, i.e., Sapote is not only nutritious, it also has a low caloric value, similar to melon (29 Kcal) and lemon (22 Kcal), (TACO, 2006).

According to Luzia & Jorge (2012), the proximate composition of fruits can be influenced by several factors, including variety, cultivar, maturity, climate and geographical conditions of production, handling during and post-harvest, processing and storage. Furthermore, the species genotype, growing conditions and the interaction between genotype and environmental characteristics may also influence directly in the composition of fruits.

Chemical analysis

The determinations of total sugars, reducing sugars, sucrose, soluble solids, pH and total acidity are shown in Table 3.

Table 3. Additional analysis of Sapote pulp obtained in the region of Goiânia, Brazil

Analyses	Mean (sd)
Total Sugars (%)	7,06 (0,22)
Reducing sugars (%)	2,88 (0,03)
Sucrose (%)	4,18 (0,24)
Soluble solids (%)	12,20 (0,56)
pH (%)	6,83 (0,03)
Acidity (%)	0,11 (0,01)

Results are reported as means ± standard deviation (sd) and are expressed in fresh weight basis (n=15).

Through these chemical analyses, it could be concluded that the levels of total sugars were close to values found by Lozano-Grande (2006), i.e., 10.23% for white Sapote grown in Mexico. Another fruit, better known, which has total sugar content close to Sapote pulp, is papaya, which shows a value of 10.16% (TACO, 2006).

The total carotenoids, soluble and insoluble total dietary fiber, total pectin and soluble pectin are show Table 4.

Table 4. Content of carotenoids, dietary fiber, pectin and phenolic compounds of Sapote pulp obtained in the region of Goiânia, Brazil.

Analyses	Mean (sd)
Carotenoids	1,91 (0,06)
Total fibers (%)	1,00 (0,10)
Soluble fibers	0,60 (0,05)
Insoluble fibers	0,40 (0,05)
Total pectin (%)	5,24 (0,18)
Soluble pectin (%)	1,82 (0,01)
TP* (EOH)	6,31 (0,81)
TP* (EA)	15,06 (4,50)

Results are reported as means ± standard deviation (sd) and are expressed in fresh weight basis, (n=15). *TP: total phenolics expressed as mg GAE (gallic acid equivalent). $100g^{-1}$ (EOH - alcoholic extract, EA - aqueous extract).

Carotenoids were quantitatively determined and the value obtained was higher than that found by Alegría et al. (2005) which found a mean value of 1.1 $\mu g.g^{-1}$. This difference may be due to the methodology used, since the former study used a longer extraction time when compared to that used in this work, which may have affected negatively the quality of carotenoids by oxidation. The loss or alteration of carotenoids can also occur during processing and storage, and through physical removal such as shelling and because they are highly unsaturated compounds by geometric isomerization and enzymatic and nonenzymatic oxidation (RODRIGUEZ-AMAYA, 1997). In a recent study conducted by Gorinstein *et al.* (2010), a value of 15.18 $\mu g.g^{-1}$ of total carotenoids was found in mango and 9.47 $\mu g.g^{-1}$ in avocado, i.e., Sapote pulp has a relatively low value compared to these fruits.

The total dietary fiber content is similar to that found in grapes (1.20%) and in tomato raw (1.20%) according to Dhingra *et al.* (2012). The fibre may act as a protective factor in cancer of the large bowel by shortening transit time, thus reducing the time for formation and action of carcinogens. In addition, through its stool-bulking effect, fibre may lower the concentration of fecal carcinogens thereby reducing the amount of carcinogen that comes in contact with the gut wall (DHINGRA *et al.*, 2012).

In Sapote pulp, the pectin content is significant, given that potato has a content of 2.5% and apple from 5.0 to 7.0%. According to Alegría et al. (2005), Sapote pulp has a pectin content of 8.5%. This difference may be due to differences in the maturity degree of the fruits analyzed, as well as the variety, or even the presence of molecules and structures within the pectin in the fruit that at any time, may influence the extraction process. The soluble pectin represents almost 40% of total pectin, and this content is significant, and the fruit can be considered a prebiotic food, i.e., it is a food of vegetal origin, which has beneficial effects in modulating the composition of the intestinal microbiota, playing an important role in intestinal physiology, reducing colon cancer, reducing cholesterol and controlling blood glucose (GONÇALVES *et al.*, 2007). Since pectin in water results in viscous solutions, even at low concentrations in the presence of sucrose and acid, and forms very stable gels, the possibility of transforming Sapote pulp into jams is very feasible, besides being an alternative for preserving the fruit.

The concentration of total phenolics, given in milligrams of gallic acid per 100g of sample, found for the aqueous and alcoholic extracts, correlates to the value of total antioxidant activity found. Phenolic compounds were identified as the compounds with higher antioxidant capacity in fruits. Phenols cover a wide variety of compounds derived from the metabolism of phenylpropanoic compounds. In a study by Oboh & Ademosun (2012) about characterization of the antioxidant properties of phenolic extracts from some citrus peels, it was high antioxidant properties of the free and bound phenolic extracts from orange peels could be harness in the formulation of nutraceuticals and food preservatives. The value found in this study is lower than average of varieties soursop (78.5 mg GAE. 100 g^{-1}) and the sweetsop (65.5 mg GAE. 100 g^{-1}) reported by Luzia & Jorge (2011).

CONCLUSION

Sapote pulp is abundant in water and sugars and has low pH, giving it a sweet and smooth flavor. Due to its physical and chemical properties, Sapote pulp shows good potential for agro-industrial processing.

The high pectin content favors the production of jams, as a means of preserving the fruit and disclosing it to Brazil and even to the international market.

Since the Sapote fruit has large amounts of fiber, it can be considered a source of dietary fiber, and can be used as a prebiotic food, which improves the beneficial effects on intestinal microbiota.

The nutritional importance of Sapote is due to the presence of large amounts of carotenoids, especially because some of them are precursors of vitamins.

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