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Research Article

Evaluation of the Nutritional, Mineral and Lysine Content of the Root of the *Pachira aquatic* Aubl. of the Atlántico (Colombia)

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Abstract: The objective of the study was to characterize the root of the *Pachira aquatic* Aubl, collected from the gardens of the Universidad del Atlántico. For years, roots have represented an alternative for solving food security problems due to their nutritional value, especially for indigenous communities; however, being carriers of secondary metabolites, beneficial for health, their consumption has decreased and their potential in the agroindustry and the pharmaceutical industry wasted. *Pachira aquatic* Aubl is a plant species abundantly distributed in the Colombian Caribbean region, resistant to wide ranges of temperature, humidity and salinity, develops roots that have not studied; the infusion of that of its bark considered with hypoglycemic effects. The characteristics of humidity, ash, crude fiber, proteins, lipids, carbohydrates were determined; minerals such as calcium, magnesium, zinc and iron, as well as the amino acid Lysine; The proximal analysis performed by AOAC methods, minerals by atomic absorption spectrophotometry and Lysine analysis by ultrafast liquid chromatography. The mean, standard deviation, variance and confidence intervals obtained from the results of the analyzes. The study reported an average composition of the root of the *Pachira aquatic* Aubl of: carbohydrates (72.25%), humidity (13.53%), ashes (4.64%), proteins (4.53%), crude fiber (4.39%), fat (0.64%), calcium (188.202 mg/100 g), iron (0.211 mg/100 g), zinc (0.060 mg/100 g), magnesium (0.060 mg/100 g) and lysine 0.032 mg/100 g. The nutrients found in a greater proportion were carbohydrates and calcium, also highlighting the presence of the amino acid Lysine.

Keywords: Calcium, food safety, nutrients, plant

INTRODUCTION

Flora and fauna are protagonists of biodiversity, reflect values and culture of communities, in addition to environmental services, so it is essential to safeguard and maintain ecosystems and thus promote the sustainability of natural resources (Zamorano de Haro, 2009).

Colombia, a country rich in flora and fauna, with great potential for the exploitation of its natural species such as plants, has put aside its use, necessary for self-sustainable economic development, which allows obtaining food with a high nutritional value and low cost. It has an area of 1'141,748 km^2 continental; it is located within the 14 countries of highest biodiversity on earth, under the name of mega-diversity, occupying the 4th place in the diversity of plants (Andrade Correa, 2011).

Due to the natural riches existing in the country, interest has grown in researching the nutritional properties of these and consequently, that serve as a food alternative to those present in the market. Interest in the study of flora has not only occurred in Colombia but throughout the world, which is why it is an excellent alternative to contribute to the new agri-food trends. Besides, the fact of generating a new natural food option would directly impact on the intensification of agricultural activity, with the purpose of producing more food, due to the growth of its demand.

Lysine considered an essential amino acid since the human body does not synthesize it and therefore must consume in food through foods that contain it, it has found in plant tissues such as cereals, legumes, brewer's yeast, nuts and other grains rich in protein. It is considered essential for growth; however food protein can be a means of environmental contamination because a significant amount of nitrogen is produced from it (Jackson *et al*., 2003). A strategy for reducing costs and the amount of nitrogen eliminated is to identify the amino acid profile in the essential raw materials used in the development of food products, generating a better protein balance and greater nitrogen retention in the body (Forster and Dominy, 2006).

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Attending the opportunity to achieve new nutritional alternatives to meet the needs of consumers and taking advantage of the natural resources offered in Colombia, we proceeded to study the *Pachira aquatic* Aubl, also called indian chestnut, money tree or water zapote, native species from southern Mexico to northern Brazil. There have been studies related to the leaves, fruits and seeds of the *Pachira aquatic* Aubl, but the root has not studied; said plant is known to be used for ornamental purposes, primarily to decorate or decorate open spaces, since due to its large size, it provides enough shade. Another characteristic for which this plant is known is its edible oilseeds, which eaten toasted and can also be ground and prepared as chocolate (Ospina, 2010).

Andrade-Cetto and Heinrich (2005) studied the species commonly used in Mexico for the treatment of diabetes, being considered as hypoglycemic agents, among them the *Pachira aquatic* Aubl, qualities attributed especially to the infusion of the bark of the plant.

Infante-Mata *et al*. (2014) studied the *Pachira aquatic* in Mexico as a high tide mangrove species. They stated that its rapid growth, high germination rate and resistance to salinity make it a species to reforest the mangroves and recommended its conservation and use your distribution as a mangrove boundary.

The territorial expansion of this species, according to data provided by the Institute of Natural Sciences of the National University lies mainly in the Regions: Pacifica (Chocó, Cauca, Valle del Cauca, Nariño, Quibdo), Eje Cafetero (Antioquia) and Andina (Cundinamarca)) (Ospina, 2010). The difference in the places of their cultivation lies in the fact that this species is quite adaptable to different types of soil. It grows well in full sun or partial shade and is resistant to drought and floods (Montoso, 2007).

The objective of the study was to perform a proximal evaluation, mineral (calcium, iron, magnesium, zinc) and the content of the amino acid Lysine of the root of the *Pachira aquatic* Aubl, to determine its nutritional value.

MATERIALS AND METHODS

Collection and treatment of samples: The samples of the root of the *Pachira aquatic* Aubl obtained from the gardens of the Universidad del Atlántico, municipality of Puerto Colombia, located in the northwest of the department of Atlántico, the metropolitan area of Barranquilla. (Latitude: 10 ° 59'2 "; Length: 74 ° 57'2 "; Altitude: 49,2 ft above sea level). Copies were selected in excellent condition, free of damage by insects, fungi or diseases; the excess soil was removed, with the use of clean knives and stored in labeled bags. Then the roots were rinsed with potable water, dried under sunlight for three days, then placed in a natural convection drying oven brand Memmert, at 176°F for 2 h. The dry samples stored in glass jars lined with aluminum foil, in a cool place without humidity, to prevent oxidation.

The samples were collected from October to November 2016, the sampling of the different cultivated plants was done randomly in the gardens, to obtain a representative sample.

The size of the sample used for the realization of the proximal and Lysine analysis was 100 g and for the mineral analysis it was 300 g; for each parameter, a sample analyzed in triplicate.

Proximal analysis: The moisture content determined to employ AOAC 930.15 a (AOAC, 2005), which consists of the weight loss of the sample after placing it in the heat and its value by weight difference between the dry material and the wet material, the MB 35 Halogen moisture balance used.

The ash content determined using AOAC 942.05 b (AOAC, 2013), which developed through the loss of weight that occurs when the product incinerated at 1022°F with the destruction of organic matter that is lost through volatilization, using the Terrígeno muffle furnace.

The determination of crude fiber determined using AOAC 962.09 c (AOAC, 2010), which based on the loss of mass corresponding to the incineration of the organic residue that remains after digestion with solutions of sulfuric acid (H_2SO_4) and sodium hydroxide (NaOH) under standardized conditions, the Raw Fiber Extractor Fiwe equipment used.

The determination of proteins was carried out by the AOAC (2005), which is characterized by the use of boiling, concentrated H_2SO_4, which affects the oxidative destruction of the organic matter of the sample and the reduction of the natural nitrogen to ammonia. The ammonium is retained as bisulfate of ammonium and can be determined in situ or by alkaline distillation and titration. A digester, a Scrubber filter B-414 and a distiller K-414 used.

The determination of fats was carried out by AOAC (2012) d, which consists of the removal of fats and fat-soluble substances from the dried material, by using an anhydrous solvent and is determined gravimetrically after the evaporation of the solvent. He used the SR 148 Solvent Extractor equipment.

The determination of carbohydrates was carried out using the percentage difference method, obtained by the difference of 100, of the percentage of proteins, fats, ash and moisture (AOAC, 2005). The energy value was determined from the application of the Atwater factors (Novotny *et al*., 2012).

Mineral analysis: The determination of minerals was carried out taking as reference the (USP Pharmacopeial Convention, 2005), with the use of the spectrophotometer of atomic absorption Spectraa FS and 240 Z for the determination of the minerals calcium, magnesium, zinc, iron. This method of analysis transforms the sample of atoms into a state of vapor and measures the electromagnetic absorption emitted or absorbed by these particles. A calibration curve was made, using three known concentrations of the minerals that were quantified and in this way, the correct measurement of the levels of the material studied was guaranteed. The samples analyzed in the spectrometer for 20 min and the concentrations obtained expressed in mg/ (of each mineral) 100 g (of the dry sample).

Analysis of amino acids: For the determination of the amino acid Lysine the method used by Ultrafast Chromatography (UFLC). The preparation of the sample was carried out according to method 994.12 of the AOAC (1997) e, which consists of hydrolyzing the samples at 110°C/24 h in 6 N hydrochloric acid (HCl).

The following statistical analysis performed on the information collected: mean, standard deviation, the variance of the sample and confidence interval, to know the dispersion of the results.

RESULTS AND DISCUSSION

In the development of plants, variables such as temperature, solar radiation, availability of water and the availability of essential mineral elements and through the modification of patterns of distribution of biomass, especially the storage of reserves in the organs, influence, it is possible to cover the environmental deficiencies (Cabezas and Sánchez, 2008). Table 1 shows the statistical results of the proximal analysis, the content of minerals and Lysine of the root of the *Pachira aquatic*. Table 2 shows the comparison of the nutrient content of the *Pachira aquatic* with other edible roots observed; in the proximal analysis of the *Pachira aquatic*, it noted that the highest nutrient was carbohydrates (72.25%±0.10) and the mineral present in highest concentration was calcium (188.2±0.025). This results can attribute in general, nitrogen and phosphorus deficiencies produce carbohydrate accumulation in the leaves, high amounts of carbon in the roots and an increase in the root/aerial allometric ratio (Gutiérrez Colomer *et al*., 2006). As well as some effects of nitrogen insufficiency, are consistent with the carbon/nitrogen ratio in tissues, caused by the presence of free carbohydrates. The carbon metabolites and the carbon/nitrogen ratio regulate the expression of genes involved in nitrogen uptake and metabolism and nitrates provide for the expression of many genes responsible for the metabolism of sugars (Hermans *et al*., 2006; Guo *et al*., 2007). The carbohydrate content of *Pachira aquatic* is higher than the other edible roots, including yucca, which has been considered the primary source of starch in multiple tropical regions (Llorens, 2004). The most common carbohydrates found in this type of foods are soluble carbohydrates, clearstarch and sugars, this content depends on the degree of maturity of the root, so you must define and know the optimal time of harvest (Barrera *et al*., 2004).

Within the carbohydrates found in the *Pachira aquatic*, is the raw fiber (4.39±0.13), an essential nutrient for transit and intestinal rhythm and maintain

Table 1: Turned out proximal analysis, minerals analysis and of lisina of the root of *Pachira aquatic* Aubl

Parameter	Avg. (%) and S.D.	Var.	C.I.
Moisture	13.530 (0.130)	0.0160	13.210 µ 13.850
Ash	4.640 (0.090)	0.0810	4.420 µ 4.860
Raw fibre	4.390 (0.130)	0.0170	4.070 µ 4.720
Proteins	4.530 (0.060)	0.0030	4.380 µ 4.680
Fats	0.640 (0.015)	0.0002	0.610 µ 0.680
Carbohydrates	72.250 (0.100)	0.0090	72.000 µ 72.490
Calcium	188.200 (0.025)	11.2920	188.100 µ 188.300
Magnesium	0.060 (0.001)	0.0030	0.056 µ 0.064
Zinc	0.060 (0.002)	0.0030	0.550 µ 0.550
Iron	0.211 (0.002)	0.0120	0.206 µ 0.216
Lysine	0.032 (0.002)	0.0001	0.027 µ 0.037

Avg.: Average; S.D.: Standard deviation; Var.: Variance; C.I.: Confidence interval

Table 2: Comparison of the content of nutrients of the root of the *Pachira aquatic* Aubl with other eatable roots

Parameter	*Pachira aquatic*	Yucca	Carrots	Radish	Parsley
Moisture (%)	13.530	60.9	88.9	94.7	86.9
Proteíns (%)	4.530	0.9	0.7	0.8	2.9
Lipids (%)	0.640	0.1	0.1	0.1	3.0
Carbohydrates (%)	72.250	37.1	8.4	3.0	6.9
Energy (Kcal)	313.000	153.0	37.0	16.0	48.0
Calcium (mg)	188.200	7.0	27.0	8.0	11.0
Magnesium (mg)	0.060	-	0.2	-	-
Zinc (mg)	0.060	-	0.4	-	-
Iron (mg)	0.211	0.7	0.4	-	0.6
Lysine	0.032				

Table of chemical composition of Colombian foods, 2015 the ecosystem of the bacterial flora (García Peris and Velasco Gimeno, 2007). Other factors to be present in the fiber content are also the origin and variety of the vegetable.

The organic matter decomposed by the action of bacteria and fungi that release nutrients to the earth, remaining available to be absorbed by the plant species, a form of direct absorption is through the roots (Martínez and Pugnaire, 2009). The mineral pattern depends on the place of cultivation (El-Razek and Hassan, 2011), these dissolved in the soil and the root absorbs them in the form of ions, which achieved when the minerals come into contact with the root system. The high content of calcium found in the root of *Pachira aquatic* is related to the high content of carbohydrates. Several trials consider that this is a crucial element when distributing assimilates, especially in storage organs (Lenz, 2000; Hanafi and Halimah, 2004; Hao and Papadopoulos, 2004). The *Pachira aquatic* has a calcium content higher than that found in other edible roots such as cassava, carrots, radishes and parsley, with its lower magnesium and zinc content, these values related to the high ash content (4.64±0.09); vital aspect to consider for future studies since the high content of ash and fiber can affect the digestibility of food (Yang *et al*., 2009).

The moisture content of *Pachira aquatic* is the lowest of the edible roots studied, possibly due to the drought present in the Colombian Caribbean region in recent years due to the El Niño phenomenon. Therefore the research and development of plants materials resistant to drought, such as the *Pachira aquatic*, are essential for their contribution to the food security of the population (Polanía *et al*., 2009). The roots are necessary to maintain the absorption of water in dry soils as an adaptation feature (Huang and Gao, 2000). Another aspect that could affect humidity in the *Pachira aquatic* was the degree of maturation at the moment of root collection, which is essential since it has been observed that at lower moisture content, there is a higher content of dry matter (Barrera *et al*., 2004). In addition to a higher degree of maturation lower moisture content in vegetables, also the variety studied of each species is another important factor (Morillas-Ruiz and Delgado-Alarcon, 2012).

The caloric intake for each 100 g of the edible part of the root of the *Pachira aquatic*, reported an average value of 313 kcal, the highest of the origins studied, which is attributed mainly to the high content of proteins and carbohydrates.

The protein content in the root of *Pachira aquatic* (4.53±0.06) was higher than that found in the other edible roots studied. The quality or availability of proteins is a function of their amino acid content (Terrazas *et al*., 2010), such as Lysine, present in this root (0.032±0.002). However, the amino acid calculations of the Andean tubers show that they are biologically incomplete, that is they have a lower number of essential amino acids than the reference standard of the FAO/WHO/UNU (1985). However, this can be solved starting from of the combination of various types of food in the diet (Barrera *et al*., 2004). This is related to the study carried out by Oliveira *et al*. (2000), where it stated that the root *Pachira aquatic* Aubl has a high content of proteins, oil, as well as its seeds and its Lysine content stands out, despite the poor content in essential amino acids such as tryptophan, threonine and phenylalanine.

Regarding the fat content, it was observed low in most vegetables, which agrees with the statement by Morillas-Ruiz and Delgado-Alarcon (2012), who state that the lipid content does not usually exceed 1/100 g in vegetables as fruits and vegetables.

CONCLUSION

In the analysis of the chemical composition of the root of the *Pachira aquatic* Aubl, carbohydrates were the nutrient found in higher proportion, followed by calcium and proteins, these results were superior to those found in the roots cassava, carrot, radish and parsley. On the other hand, humidity was low in the *Pachira aquatic* about the different roots studied. As a result of the high content of carbohydrates and proteins, its energy value was higher. The essential amino acid Lysine found, necessary for muscle growth and development.

The results obtained indicate that the root *Pachira aquatic* Aubl presents nutritional characteristics that make it suitable to be introduced in animal or human food or serve as a base for the elaboration of dietary supplements.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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