Original

Nutritional composition, fatty acid and tocopherol contents of buriti (*Mauritia flexuosa*) and patawa (*Oenocarpus bataua*) fruit pulp from the Amazon region

Composição centesimal, em ácidos graxos e tocoferóis das polpas amazônicas de buriti (Mauritia flexuosa) e de patauá (Oenocarpus bataua)

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Abstract

Buriti and patawa are two endemic palm trees from the Amazon region. Their pulps are traditionally consumed by the local population, but are underused and lesser known worldwide. Nutritional composition, fatty acid and tocopherol contents of the two palm pulps were determined by modern analytical methods: Gas Chromatography (CG) and High Performance Liquid Chromatography (HPLC), based on the standards of AOCS (AMERICAN..., 2002) and AOAC (ASSOCIATION..., 1997), respectively. Buriti and patawa fruit pulps are highly nutritive, with respectively, high fat content (38.4% and 29.1% of dry matter (DM)), protein content (7.6% and 7.4% of DM) and dietary fibers (46% and 44.7% of DM). Buriti pulp can be considered healthy food due its high content of vitamin E (1169 μg.g^{-1} DM). Patawa pulp is highly oleaginous and its fatty acid composition is very similar to the ones of healthy oils, such as olive oil.
Keywords: *Amazon; pulp; fruit; palm; buriti; Mauritia flexuosa; patawa; Oenocarpus bataua; lipids; fatty acids; tocopherols.*

Resumo

O buriti e o patauá são duas palmeiras endêmicas da região Amazônica. As polpas destes frutos são tradicionalmente consumidas pela população local, mas ainda não ganharam os mercados nacional e internacional. A composição nutricional em ácidos graxos e tocoferol foi determinada com metodologias analíticas modernas de cromatografia gasosa (CG) e cromatografia líquida de alta eficiência (CLAE) baseadas nos padrões da AOCS (AMERICAN..., 2002) e AOAC (ASSOCIATION..., 1997), respectivamente. As duas polpas se mostraram bastante energéticas, com uma alta concentração em ácidos graxos, respectivamente 38,4% e 29,1% em massa seca (MS), em proteínas, 7,8% e 7,4% MS e em fibras dietéticas, 46% e 44,7%. A polpa de buriti pode ser considerada uma ótima fonte de vitamina E devido ao seu alto teor de tocoferol (1169 μg.g^{-1} MS). O perfil de ácidos graxos encontrados para a polpa de patauá foi muito semelhante ao de azeite de oliva.
Palavras-chave: *Amazônia; polpa; fruto; palmeira; buriti; Mauritia flexuosa; patauá; Oenocarpus bataua; lipídios; ácidos graxos; tocoferol.*

1 Introduction

The Amazon basin is the most species-rich neotropical lowland rain forest in the world (GENTRY; DODSON, 1987; TOMLINSON, 2006). One common characteristic component of the Amazon landscape is the omnipresence of palms trees (MONTUFAR; PINTAUD, 2006). Palm trees have always been important to the subsistence of population. The local population uses all parts of palms trees, and the fruits are well appreciated. The exotic flavor and pulp composition of palm fruits are better compared to any temperate fruits. Consequently, there is an increasing interest and demand for palm pulps on the Brazilian and international markets, but one limitation of palm use in the cosmetic and food industries is the lack of information on its chemical and nutritional composition. Several lesser-known palm fruit pulps that are traditionally consumed in the Amazon region are not well characterized and could be potential healthy foods of high nutritional value (VIETMEYER, 1984). For this purpose, the aim of this study was to characterize the fruit pulps of two Amazon palm trees.

Buriti (*Mauritia flexuosa*) is endemic and well distributed in the northern Brazilian region. This palm tree belongs to the *Calamoideae* subfamily, 15-20 m tall and typical of muddy waterside of river and islands. Its fruit is about 75 g in weight, with red peel and composed of many hard layers. The stone is about half the weight of the fruit. The pulp is orange colorful, oleaginous and tasty. Buriti fruit pulp has a high content of vitamin A (ROSSO; MERCADANTE, 2007), but there are few data on other compounds (FRANÇA et al., 1999). Crude oil is used to fry food, like fish.

Patawa (*Oenocarpus bataua*) belongs to the *Arecoideae* subfamily and it is a lesser-known palm tree; the fruit pulp is not well characterized and it could present interesting nutritional

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value (STEWART, 1994). Patawa belongs to the *Areceae* tribe and to the same subtribe (*Euterpeinae*) as bacaba and assai, well known palms that produce very appreciated and healthy fruits (SCHAUSS et al., 2006; MERTENS-TALCOTT et al., 2008). It is a palm tree from the rain forest along the Amazon River and is commonly used by the local population (MILLER, 2002). The palm tree is about 15 m tall and the fruits are cherry black in color and plum fruit size. The pulp is about 40% of the fruit weight and is used to prepare a grey colored juice highly consumed in the Amazon region.

The purpose of this work was to study the nutritional and chemical characterizations of these two palm fruit pulps as well as to establish a healthy daily consumption recommendation.

2 Materials and methods

2.1 Material

All fruits were collected at the metropolitan region of Belem, State of Para, Brazil. Buriti pulp was manually removed from the stone and hard skin. Patawa pulp was extracted through mechanical process using low-speed grinder. All the pulp was lyophilized for analytical analysis. The fatty acid calibration solution, reference 74X, was obtained from Nucheck Company (USA). Tocopherol sets (each containing one 50-mg vial of D-α-tocopherol, D-β-tocopherol, D-γ-tocopherol and D-δ-tocopherol) were purchased from Matreya Corporation (USA).

2.2 Nutritional composition determination

Pulp composition was determined through the official protocols (ASSOCIATION..., 1997; AMERICAN..., 2002). AOAC 931.04 method was used to establish the moisture content of fresh and dry pulp. Ashes content and lipid content were performed following instructions of AOAC 940.26 protocol. Total nitrogen content was determined using AOAC 920.152 and KJELDAHL methods. The nitrogen-to-protein conversion factor used was 5.24, optimized for lipid-rich wild fruits (LEVEY; BISSELL; O'KEEFE, 2000).

2.3 Total lipids and fatty acid composition

The total lipids were extracted from dried pulps using the BLIGH & DYER method (BLIGH; DYER, 1959). Fatty acid profiles were obtained by gas chromatography of the fatty acid methyl ester derivatives. Derivatives were isolated via saponification and esterification with KOH in methanol (0.1 M) and HCl in methanol (1.2 M). The fatty acid derivatives were extracted with hexane and put through a GC CP3380 VARIAN gas chromatograph (Varian Inc., USA). The chromatograph was equipped with a CP-Sil 88 (60 m × 0.25 mm) capillary column and a flame ionization detector (FID). Helium was used as the carrier gas and the temperature program was as follows: 3 minutes at 130 °C; gradual heating to 220 °C for 9 minutes; 35 minutes at 220 °C; cooling to 130 °C; and 130 °C for 5 minutes. Individual peaks were identified by referring to a fatty acids methyl esters standard solution, analyzed under the same operation conditions.

2.4 Tocopherol content determination

For analysis, one gram of lyophilized fruit pulp was triturated with a Turratec ultra-grid in solvent; tocopherol was then extracted using methods for milk and food matrix with high fat content (BRUBACHER; MÜLLER-MULOT; SOUTHGATE, 1991; DEBIER et al., 1999). The chromatographic separation of tocopherols were analyzed in a Shimadzu HPLC system with a C18 reverse phase Phenomenex column (Gemini, 250 mm × 4.60 mm, 5 μ particles), methanol/water mixture (95:5) mobile phase and detection by ultraviolet absorption (292 nm) and fluorescence properties (excitation 290 nm/ emission 330 nm). As an internal standard, 200 μL of tocopheryl-acetate was added to each sample. The conversion to α-tocopherol equivalent unit is obtained with coefficient 1 for α-tocopherol, 0.5 for β-tocopherol, 0.1 for γ-tocopherol and 0.03 for δ-tocopherol.

2.5 Dietary fiber determination

Before fiber determination and due to the high fat content, the oil was extracted from lyophilized pulp following AOCS Ba 3-38 methods (AMERICAN..., 2002). Official method 985.29 of AOAC, based on enzymatic and gravimetric protocols, was used to determine the dietary fiber content (ASSOCIATION..., 1997). The dietary fiber content was corrected for residual starch and protein. The protein content was determined by the combustion method (Approved Method 46-30) using N × 5.24 as conversion factor (ASSOCIATION..., 1997; LEVEY; BISSELL; O'KEEFE, 2000).

2.6 Energy

The energy content is indicated in kilojoules (kJ) and it was calculated from the food content using the energy the following factors: 17 $kJ.g^{-1}$ for protein, 37 $kJ.g^{-1}$ for fat, 17 $kJ.g^{-1}$ for available carbohydrate, and 8 $kJ.g^{-1}$ for dietary fiber (FOOD..., 2003). Available carbohydrate was calculated by subtraction.

2.7 Statistics

All analyses were performed in triplicate and the standard deviation was evaluated.

3 Results and discussion

3.1 Chemical composition

Table 1 presents the chemical composition of the two fruit pulps. Dry matter (DM) content of buriti pulp is high, 49.5%, and it is similar to other Amazon palm fruits, such as peach palm (53%) (YUYAMA et al., 2003). Patawa pulp presents higher DM content (66.5%) due to the fact that, the mechanical process of pulp extraction removes pulp and peel together and, consequently, increases fiber content.

All results are expressed as mean ± standard deviation and all analyses were performed in triplicate, except for total carbohydrate.

Carbohydrates content of buriti and patawa pulp are respectively 26.2% and 46.1% of fresh weigh (FW) (Table 1). The total dietary fibers (TDF) fraction is 22.8% FW for buriti pulp and 29.7% for patawa pulp and represents a large proportion of the pulp. TDF is interesting from a nutritional point of view, because of its many positive effects on intestinal and colon physiology. Common tropical fruits present between 9 and 13% DM of TDF, and palm tree fruits could be considered a good source of fibers. In the case of patawa, the pulp is lightly sweet and the available carbohydrate reaches 16.4% of fresh pulp.

The oil content of buriti (38.4% DM) is relatively high and similar to palm oil and widespread oleaginous crop seeds, such as canola (40%-45%) and sunflower (35%-45%) (GUNSTONE, 2001; DAUN; ACKMAN, 2001). Patawa oil content is lower, 29.1%, and it is similar to other fruits, like olive (18%-35%) (KIRITSAKIS, 2002).

The protein contents of buriti and patawa pulp are 7.6% and 7.4% of DM, respectively, and they are relatively high for tropical fruit pulp and similar to the seed composition of fruits. Amazon palm tree pulps generally have 1%-5% DM of proteins content (AGUIAR et al., 1980). Mineral content is about 1.5% of dry matter, which is a common concentration in tropical fruit pulp.

3.2 Energy

The gross energy of the two pulps is high, 1006 kJ and 1132 kJ for 100 g of fresh weight, respectively for buriti and patawa. Patawa is the most energetic due to higher concentration of fatty acids and carbohydrates – especially available carbohydrates.

3.3 Lipids composition

Unsaturated fatty acids are high in buriti and patawa oil (Table 2). The oleic acid concentration is high in buriti and patawa oil, 76% of total lipids. An essential fatty acid with nutritional interest, like linoleic acid (18:2n-6) has low concentration, respectively, 2.1% and 3.9% in buriti and patawa oil. The ratio w-6/w-3 is high due to very low linolenic acid concentration (18:3n-3), and out of diet recommendations. Both pulps present optimal ratio of saturated/unsaturated fatty acids, with 33% or less of saturated fatty acids. Patawa pulp oil ratio is 18.5% : 81.5%, similar to olive oil, indicating a healthy content of fatty acids.

All results are expressed as mean ± standard deviation and all analyses were performed in triplicate.

3.4 Tocopherol content

The tocopherol content of buriti is very high, with 1169 $\mu g.g^{-1}$ of dry matter (Table 3). The tocopherol more abundant is α-tocopherol. The total tocopherol content converted in α-tocopherol equivalent unit reaches 641 $\mu g.g^{-1}$ of dry matter. Buriti pulp was already identify as a source of pro-vitamin A (CHING; MOHAMED, 2001; ROSSO; MERCADANTE, 2007) and it is a source of vitamin E, too. Buriti pulp could be considered an optimal source of antioxidant compound. Patawa pulp presents lower concentration, 72 $\mu g.g^{-1}$ of dry matter with 78.5% of α-tocopherol, but it could be considered a source of vitamin E, in comparison to other tropical fruits (CHING; MOHAMED, 2001).

All results are expressed as mean ± standard deviation and all analysis was performed in triplicate.

Table 1. Nutritional composition of buriti and patawa fruit pulps expressed in $g.100\ g^{-1}$ in fresh weight.

Parameters	buriti (*Mauritia flexuosa*)	patawa (*Oenocarpus bataua*)
Moisture	50.5 ± 1.14	33.5 ± 0.30
Fat, total	19.0 ± 0.72	14.4 ± 0.02
Proteins, total	3.7 ± 0.02	4.9 ± 0.05
Ashes	0.6 ± 0.00	1.1 ± 0.03
Dietary fibers	22.8 ± 0.38	29.7 ± 0.14
Total carbohydrates	26.2	46.1
Energy (kJ)	1006	1132

Table 2. Fatty acids profile (% w/w DM) for buriti and patawa fruit pulps.

Fatty Acid	buriti (*Mauritia flexuosa*)	patawa (*Oenocarpus bataua*)
C15:0 (Pentadecanoic)	-	0.3 ± 0.06
C16:0 (Palmitic)	18.9 ± 0.21	13.5 ± 0.31
C16:1 (Palmitoleic)	0.3 ± 0.07	0.7 ± 0.10
C18:0 (Stearic)	1.3 ± 0.07	4.2 ± 0.42
C18:1 (Oleic)	75.7 ± 0.42	76.8 ± 0.50
C18:2 (Linoleic)	2.1 ± 0.07	3.9 ± 0.38
C18:3 (Linolenic)	tr.	tr.
C20:0 (Arachidic)	1.7 ± 0.21	0.6 ± 0.10
saturated FAs	21.9	18.6
mono-UFAs	76.0	77.5
poly-UFAs	2.1	3.9

-“ means not detected and tr. means trace concentration which is under the limit of quantification. All results are expressed as mean ± standard deviation and all analysis were performed in triplicate.

Table 3. Tocopherol content (% w/w DM) of buriti and patawa fruit pulps.

Tocopherols	buriti (*Mauritia flexuosa*)	patawa (*Oenocarpus bataua*)
α-T	37.2	78.5
β-T + γ-T	57.0	10.8
δ-T	5.8	10.7
Total ($\mu g.g^{-1}$)	1169 ± 107	72 ± 3

4 Conclusions

Two pulps are highly nutritive with high fat content and protein content. Both could be considered as healthy food with high content of dietary fibers. Buriti pulp is a good source of vitamin E, while patawa pulp of is a good source of healthy oil.

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