BRAZILIAN JOURNAL OF FOOD TECHNOLOGY

Óleo da polpa e amêndoa de bocaiúva, acrocomia aculeata (jacq.) lodd. Caracterização e composição em ácido graxos

Bocaiúva, Acrocomia Aculeata (Jacq.) Lodd., Pulp and Kernel Oils: Characterization and Fatty Acid Composition

AUTORES
AUTHORS

✉ **Priscila Aiko HIANE[1*], Manoel Mendes Ramos FILHO[1], Maria Isabel Lima RAMOS[1], Maria Lígia Rodrigues MACEDO[2]**

[1] Professores do Departamento de Tecnologia de Alimentos e Saúde Pública, CCBS, Universidade Federal de Mato Grosso do Sul, CEP 79070-900, C.P. 549, Campo Grande, MS, Brazil

[2] Professora do Departamento de Ciências Naturais, Universidade Federal de Mato Grosso do Sul, CEP 79603-021, Três Lagoas, MS, Brazil

*e-mail: prihiane@nin.ufms.br

RESUMO

Acrocomia aculeata (Jacq.) Lodd. é uma espécie comum, economicamente importante, de palmeiras encontradas no Estado de Mato Grosso do Sul. Neste trabalho foram analisadas as características físico-químicas e a composição em ácido graxo do fruto bocaiúva dessa espécie. Polpa in natura e farinha obtida da polpa da fruta apresentaram alto teor de ácidos graxos insaturados, com uma predominância de ácido oléico, que correspondeu a valores de 65,9 e 62,2% do total de ácidos graxos, na polpa e na farinha, respectivamente. O óleo da amêndoa da bocaiúva apresentou, principalmente, ácido oléico (40,2%), ácido láurico (13%) e ácido palmítico (12,6%). Durante o processamento da polpa para produzir farinha, a rancidez do óleo aumentou como resultado de oxidação. O perfil de ácidos graxos das amostras analisadas estava de acordo com o verificado em frutos de palmeira. A relação entre ácido graxo linoléico (ácido graxo da família -6) e ácido linolênico (ácido graxo da família -3) é menor que 4,0, valor máximo recomendado na dieta.

SUMMARY

Acrocomia aculeata (Jacq.) Lodd. is a common, economically important species of palm tree found in the Brazilian state of Mato Grosso do Sul. In this work, the general physicochemical characteristics and fatty acid composition of the fruit (bocaiúva) of this species were examined. The fresh pulp and flour obtained from the fruit pulp had high contents of unsaturated fatty acids, with a predominance of oleic acid, corresponding to 65.9 and 62.2% of the total fatty acid contents, respectively. The bocaiúva kernel oil contained mainly oleic acid (40.2%), lauric acid (13%) and palmitic acid (12.6%). During processing of the pulp to produce flour, rancidity of the oil increased due to oxidation. The fatty acid profile of the samples analysed agreed with that of palm trees in general. The ratio of linoleic acid (-6 family fatty acid)/linolenic acid (-3 family fatty acid) was below 4.0, the maximum value recommended for the diet.

PALAVRAS-CHAVE
KEY WORDS

Bocaiúva (Acrocomia aculeata), fatty acids, pulp and kernel oil, physicochemical characteristics.

Bocaiúva (Acrocomia aculeata), Ácidos graxos, Óleo de polpa e amêndoa, Características físico-químicas.

1. INTRODUCTION

Bocaiúva is the popular name for fruit from the palm tree Acrocomia aculeata (Jacq.) Lodd., family Palmae which is abundant in the Brazilian state of Mato Grosso do Sul. Other species of this genus also occur in this state and also in south-eastern Brazil and Central America, and they are known by common names such as macaúba, catarro coconut, macabira, mocajuba and macaíba (SILVA et al., 1994). Following maturation, the oily, semi-fibrous, mucilaginous pulp of bocaiúva is edible and has a characteristic sweet flavour (POTT & POTT, 1994; ALMEIDA, 1998). The seed (kernel) of the fruit can be eaten raw or in the form of candies, known as "paçoca" and "cocada" (SILVA et al.,1994; ALMEIDA, 1998).

The bocaiúva pulp contains yellowy red oil that can be used to produce cooking oil. The kernel also contains transparent oil that can be purified for use in cooking and the production of sweets (MACAÚBA, 1986). Oils and fats are important sources of energy for human metabolism. The effects of dietary lipids on growth and tissue fatty acid composition have been extensively investigated (SENANAYAKE & SHAHIDI, 2002; LAPOSATA et al., 2002; PARK et al., 1999; STANTON et al., 1997). The involvement of saturated fatty acids in heart disease has led to the exclusion of fats from the diet (KEONG et al., 2003; GRISDALE-HELLAND et al., 2002). Flour prepared from the pulp of mature bocaiúva (Acrocomia mokayáyba Barb. Rodr.) has high vitamin A and oil contents (HIANE & PENTEADO, 1989; HIANE et al., 1990). This composition has led to interest in this fruit as a source of raw material for food products. It is possible that the good storage properties of the whole fruit with its hard peel, being more protected against photochemical reactions (FENNEMA, 1985), could allow for the flour to be produced out of season.

AMAYA-FARFÁN et al. (1986) and HIANE et al. (1990), investigating other bocaiúva species, respectively Acrocomia sclerocarpa Mart. and A. mokayáyba (Barb.) Rodr., from the Brazilian north-eastern and central west areas, showed that the oil of the fruit pulp contained principally oleic acid followed by palmitic acid; and in the oil of the kernel, AMAYA-FARFÁN et al. (1986) found lauric and oleic acids as the predominant fatty acids.

In this work the general physicochemical characteristics and fatty acid composition of the fruit (bocaiúva) of the species Acrocomia aculeata (Jacq.) Lodd., from the Brazilian state of Mato Grosso do Sul, were examined, as well as verifying changes in the characteristics of the fruit pulp oil during processing to produce flour.

2. METHODOLOGY

2.1 Material

Bocaiúva, Acrocomia aculeata (Jacq) Lodd., fruits were collected on the campus of the Federal University of Mato Grosso do Sul. For analysis, the fresh fruits (1kg) were shelled and the pulp and kernels removed and ground. A portion of the homogenized pulp was dehydrated in a forced ventilation oven at 40-50°C for 4h and then blended and sifted to obtain pulp [autor foi "pulp" ou "flour"?].

The oil in the fresh pulp, pulp flour and kernels was extracted by the Bligh & Dyer method, as described by KATES (1972), in order to determine its physicochemical properties and fatty acid composition.

2.2. Methods

2.2.1. Oil content

The oil content was determined by direct extraction in a Soxhlet apparatus, using petroleum ether (boiling point 40-60oC), according to standard procedures (INSTITUTO ADOLFO LUTS, 1985).

2.2.2. Physicochemical characteristics

The physicochemical characteristics of the fresh pulp, pulp and kernel oils were determined by standard procedures recommended by THE INSTITUTO ADOLFO LUTZ (1985) and the AMERICAN OIL CHEMISTS' SOCIETY - AOCS (1998).

For acidity, an aliquot of oil was weighed, dissolved in ethyl ether:ethanol (2:1, v/v) and titrated with 0.1mol/L sodium hydroxide. The iodine content was determined by the method of Wijs, using Wijs solution and 0.1mol/L sodium thiosulphate. The refractive indices of the pulp and kernel oils were determined in an Abbé refractometer. The saponification value was determined by saponification with 4% potassium hydroxide and titration with 0.5N HCl. The peroxide content of the oil was determined according to the AOCS method.

2.2.3. Fatty acid composition

After extraction, the oils were saponified and the fatty acids converted to methyl esters as described by HARTMAN & LAGO (1973).

The fatty acid methyl esters were analysed, using a model Star 3400 Varian Gas Chromatograph, equipped with a flame ionisation detector, a split/splitless injector and a capillary column of melted silica (30 m x 0.25 mm, J & Scientific, USA), containing polyethylene glycol (D B Wax) as the stationary phase. The chromatographic conditions used included: detector temperature of 260°C, injector temperature of 250°C, column temperature of 200°C for 20 min, programmed for 1°C per minute up to 220°C, hydrogen gas with flow rates of 1.1mL/min., make-up gas of nitrogen for 22mL/min.

The fatty acids were identified by comparing the retention times of the sample peaks with those of methyl ester standards of the fatty acids. The areas of the peaks were calculated and expressed as a percentage of the total area.

3. RESULTS AND DISCUSSION

3.1 Oil content and physicochemical characteristics

Table 1 shows that the fresh pulp, flour and kernels of bocaiúva were rich in oils with values of 16.5, 19.3 and 52.9% (on a wet basis), respectively.

The acidity and peroxide content of the pulp flour were higher than those of the fresh pulp, indicating that the processing of bocaiúva pulp at 40 to 50°C to obtain flour led to the breakdown of glycerides with the release of free fatty acids and oxidation of the oil. Despite these higher values, the flavour of the product was unaltered, since fresh pulp contains lipolytic enzymes that hydrolyse the oil soon after maturation of the fruit, thereby releasing low molecular weight fatty acids and glycerol that give the fruit its characteristic flavour (MACAÚBA, 1986; LAGO et al., 1991).

Compared to oils from other palm tree fruits, the bocaiúva pulp and kernel oils showed lower acidity values than those found in buriti, palm and palmiste oils (TAVARES et al., 1990; SERRUYA et al., 1980); and these values were also low in comparison to the maximum allowable acidity for raw or virgin edible oils, such as olive and palm oils (maximum of 5.0%) (BRASIL, 1999).

The saponification values agreed with those commonly found for the edible and refined oils (usual range: 181-265) (BRASIL, 1999), and the iodine content was higher than reported for the pulp and kernel of palm oil (BRASIL, 1999; TAVARES et al., 1990).

3.2 Fatty acid composition

Table 2 shows the fatty acid compositions of bocaiúva pulp, pulp flour and kernel oil. In the pulp and pulp flour, there was a predominance of oleic acid, with levels similar to those found in the fruit of other palm trees (LAGO et al., 1991; SERRUYA et al., 1980; TRUJILLO-QUIJANO et al., 1992; AMAYA-FARFÁN et al., 1986; SOUZA et al., 1986; MESQUITA et al., 2001), palmitic acid being the second most abundant fatty acid, in agreement with previous reports (HIANE et al., 1990; AMAYA-FARFÁN et al., 1986). Oleic acid was the predominant fatty acid in the bocaiúva kernel, followed by lauric acid, whilst lauric acid was the predominant fatty acid in the kernel oil of other previously reported bocaiúva species (AMAYA-FARFÁN et al., 1986).

The fresh pulp and pulp flour showed similar contents of monounsaturated fatty acids (66.9 and 66.4%, respectively) to those verified in edible oils rich in these fatty acids, such as olive (56-87%), peanut (15-47%) and canola oil (54-75%) (BRASIL,1999).

In the fruit kernel, 42.5% of monounsaturated fatty acids and a high value of saturated acids (49.7%) were observed. Other palm kernel oils, such as palmiste oil (Elaeis guineensis Jacq.), presented lower monounsaturated (12-19%) and higher saturated (69-98%) acid values than those verified in the kernel studied here (BRASIL, 1999).

With respect to the -3 family of fatty acids, the linolenic acid values for bocaiúva pulp, pulp flour and kernel (respectively, 2.5; 2.7 and 1.9%) were high when compared to the values for olive (0.5%), sunflower (1%), corn (1%) and palm oils (1%) (BELDA & POURCHET-CAMPOS, 1991). The data found were above the recommended dietary intake for the adult man (THE NATIONAL ACADEMIES PRESS, 2002).

TABLE 1 Physicochemical characteristics of the in natura pulp, pulp flour and kernel oil of bocaiúva, Acrocomia aculeata (Jacq.) Lodd., from the state of Mato Grosso do Sul.

CHARACTERISTICS	PULP	PULP FLOUR	KERNEL
Acidity, in oleic acid (%, w/w)	0.83	3.14	0.21
Iodine (WIJS)	75.43	74.04	54.05
Saponification index (mg KOH/g oil)	210.50	206.30	258.00
Refractive index at 40°C	1.4609	1.4615	1.4539
Peroxide value (mEq/kg oil)	2.09	5.80	0.00
Oil content (g/100 g on a wet basis)	16.50	19.30	52.90

TABLE 2 Oil fatty acid composition (%) of the in natura pulp, pulp flour and kernel of the bocaiúva, Acrocomia aculeata (Jacq.) Lodd. from the state of Mato Grosso do Sul.

FATTY ACID	PULP	PULP FLOUR	KERNEL
Capryllic acid (C8)	0.45	0.41	5.96
Capric acid (C10)	0.27	0.23	1.79
Lauric acid (C12)	1.97	1.98	12.95
Myristic acid (C14)	0.45	0.42	9.49
Palmitic acid (C16)	15.96	18.53	12.62
Palmitoleic acid (C16:1)	1.01	4.19	2.29
Stearic acid (C18)	5.92	4.88	6.58
Oleic acid (C18:1)	65.87	62.16	40.17
Linoleic acid (C18:2)	5.10	4.03	5.91
Linolenic acid (C18:3)	2.52	2.74	1.92
Araquidic acid (C20)	0.50	0.53	0.30
% SFA	25.52	26.98	49.69
% MUFA	66.88	66.35	42.46
% PUFA	7.62	6.77	7.83
MUFA/SFA	2.62	2.46	0.82
PUFA/SFA	0.30	0.25	0.15

SFA= Saturated fatty acids
MUFA= Monounsaturated fatty acids
PUFA= Polyunsaturated fatty acids

4. CONCLUSIONS

The results obtained show that the pulp, flour and kernels of the bocaiúva presented profiles similar to those of other palm tree fruits with respect to the physicochemical

characteristics and fatty acid compositions in general.

Processing of the pulp to obtain bocaiúva flour led to alterations with respect to oxidative rancidity. Due to the high saturated fatty acid content of the bocaiúva kernel oil, this showed greater stability to lipid peroxidation than the pulp and the flour.

Evaluating the nutritional quality indices, it was observed that the ratio of PUFA (Polyunsaturated fatty acids)/SFA (Saturated fatty acids) for the samples analysed was lower than the recommended value. However, the ratio between linoleic acid (**ω**-6 family fatty acid) and linolenic acid (**ω**-3 fatty family acid) was below 4.0, which is the maximum recommended value for the diet, according to the English DEPARTMENT OF HEALTH (1994). Thus, since the lipid contents were high in the in natura and processed bocaiúva pulps as well as in the fruit kernel, it can be considered as a good source of linolenic acid, a fatty acid belonging to the -3 family, the levels of this acid being above the recommended dietary quota.

5. REFERENCES

ALMEIDA, S.P. Cerrado: aproveitamento alimentar. Planaltina: EMBRAPA-CPAC, 1998. 188p.

AMAYA-FARFÁN, J.; RODRIGUEZ-AMAYA, D.B.; NOLETO CRUZ, P.; MARQUES, E.P. Fatty acid and amino acid composition of some indigenous fruits of northeastern Brazil. Ciênc. Tecnol. Aliment. 6, 86-92, 1986.

AMERICAN OIL CHEMISTS' SOCIETY. AOCS. Official methods and recommended practices of the AOCS. 5th. Illinois, 1998.

BELDA, M.C.R.; POURCHET-CAMPOS, M.A. Ácidos graxos essenciais em nutrição: uma visão atualizada. Ciênc. Tecnol. Aliment. v.11, n.1, p.5-35, 1991.

BRASIL.Ministério da Saúde. Agência Nacional de Vigilância Sanitária. Resolução nº 482, de 23 de Setembro de 1999. Regulamento técnico para fixação de identidade e qualidade de óleos e gorduras vegetais. Disponível em: http://www/anvisa.gov.br.

DEPARTMENT OF HEALTH. Report on health and social subjects nº 46. Nutritional Aspects of Cardiovascular Disease. HMSO, London, 1994, 178p.

FENNEMA, O.R. Food chemistry. New York, Marcel Dekker, 1985. 991p.

GRISDALE-HELLAND, B.; RUYTER, B.; ROSENLUND, G.; OBACH, A.; HELLAND, S.J.; SANDBERG, M.G.; STANDAL, H.; ROSJO, C. Influence of high contents of dietary soybean oil on growth, feed utilization, tissue fatty acid composition, heart histology and standard oxygen consumption of Atlantic salmon (Salmo salar) raised at two temperatures. Aquaculture, 207, 311-329, 2002.

HARTMAN, L.; LAGO, R.C.A. Rapid preparation of fatty acid methyl esters from lipids. Lab. Pract. London 22, 475-494, 1973.

HIANE, P.A.; PENTEADO, M.V.C. Carotenóides e valores de vitamina A do fruto e da farinha de bocaiúva (Acrocomia mokayáyba Barb. Rodr.) do Estado de Mato Grosso do Sul. Revista Farm. Bioquím. Univ. S. Paulo, v.25, n.2, p.158-168, jul/dez, 1989.

HIANE, P.A.; PENTEADO, M.V.C.; BADOLATO, E. Teores de ácidos graxos e composição centesimal do fruto e da farinha da bocaiúva (Acrocomia mokayáyba Barb. Rodr.). Alim. Nutr., São Paulo v.2, p.21-26, 1990.

INSTITUTO ADOLFO LUTZ. Normas analíticas do Instituto Adolfo Lutz. 3rd ed. São Paulo, 1985. v.1. 533p.

KATES, M. Techniques of lipidology. London, North-Holland. American Elsevier Publ. Co. 1972. 610p.

KEONG Ng, W.; KIN LIM, P.; LIM BOEY, P. Dietary lipid and palm oil source affects growth, fatty acid composition and muscle -tocopherol concentration of African catfish, Clarias gariepinus. Aquaculture, 215, 229-243, 2003.

LAGO, R.C.A.; PEREIRA, D.A.; PASSOS, P.R.A.; ROCHA, A.N.F.; JABLONKA, F.H.; SZPIZ, R.R. Triacilgliceróis de óleo de amêndoa de macaúba. Ciênc. Tecnol. Aliment. Campinas 11, 66-79, 1991.

LAPOSATA, M.; HASABA, A.; BEST, C.A.; YOERGER, D.M.; McQUILLAN, B.M.; SALEM, R.O.; REFAAI, M.A.; BRITT, L.S. Fatty acid ethyl esters: recent observations. Prostaglandins, 67, 193-196, 2002.

MACAÚBA. Guia Rural, Rio de Janeiro, (Abr.), 339,1986.

MESQUITA, I.V.U.; BORA, P.S.; NARAIN, N. Extração e caracterização de óleo de frutos da palmeira imperial (Roystonea princips). In: SIMPÓSIO LATINO AMERICANO DE CIÊNCIAS DE ALIMENTOS, 4, Campinas, 2001. Livro de resumos, SLACA, Campinas, 2001, p.239.

PARK, Y.; ALBRIGHT, K. J.; STORKSON, J.M.; LIU, W.; COOK, M.E.; PARIZA, M.W. Changes in body composition in mice during feeding and withdrawal of conjugated linoleic acid. Lipids, 34, 243-248, 1999.

POTT, A.; POTT, V.J. Plantas do Pantanal. EMBRAPA. BrasiliaDF. 1994. 320p.

SENANAYAKE, S.P.J.N.; SHAHIDI, F. Positional distribution of FA in TAG of enzymatically modified borage and evening primrose oils. Lipids, 37, 803-810, 2002.

SERRUYA, H.; BENITOS, M.H.S.; SIMÕES, J.C.; COBATO, J.E.; MULLER, A.H.; ROCHA FILHO, G.N. Análise dos óleos das frutas de 3 palmáceas da região Amazônica. Anais Assoc. Bras. Quim. Belém 21, 93-96, 1980.

SILVA, J.A.; SILVA, D.B.; JUNQUEIRA, N.T.V.; ANDRADE, L.R.N. Frutas nativas dos cerrados. Brasília: EMBRAPA-CPAC: EMBRAPA-SPI, 1994. 166p.

SOUZA, M.C.P.; MAIA, G.A.; ORIÁ, H.F.; GUEDES, Z.B.L.; FROTA, L.F. Composição de ácidos graxos da fração lipídica da polpa do buriti (Mauritia vinifera Mart.). Rev. Bras. Frutic. Cruz das Almas 8, p.19-24, 1986.

STANTON, C.; LAWLESS, F.; KJELLMER, G.; HARRINGTON, D.; DEVERY, R.; CONNOLLY, J.F.; MURPHY, J. Dietary influences on bovine milk cis-9, trans-11-conjugated linoleic acid content. J. Food Sci. 62, 1083-1086, 1997.

TAVARES, M.; BADOLATO, E.S.G.; CARVALHO, J.B.; AUED, S. Óleo de amêndoa de palma (palmiste) brasileiro: caracterização e composição em ácidos graxos. Rev. Inst. Adolfo Lutz 50, 307-312, 1990.

THE NATIONAL ACADEMIES PRESS. Food and Nutrition Board. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and aminoacids (2002) (macronutrients table). Disponível em: www.nap.edu.

TRUJILLO-QUIJANO, J.A.; ESTEVES, W.; PLONIS, G.F.; RODRIGUEZ-AMAYA, D.B. Variação do perfil de ácidos graxos do óleo de polpa de frutos de diferentes palmeiras oleoginosas. Ciênc. Tecnol. Aliment. 12, 91-96, 1992.