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Nutritional composition of caferana (*Bunchosia armeniaca*) fruit: a rich source of lycopene

Composição nutricional do fruto de caferana (*Bunchosia armeniaca*): uma rica fonte de licopeno

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A B S T R A C T

The present study aimed to evaluate the nutritional quality of the caferana fruit, focusing on the content and profile of carotenoids due to the characteristic coloring of these compounds. The fruits were collected, botanically identified, and evaluated for proximate composition, carotenoid and sugar content and profile, and flavonoid profile. The results of the centesimal composition of the caferana pulp were: 65 g/100g of moisture; 0.72 g/100g of ash; 0.92 g/100g of protein; 0.78 g/100g of ethereal extract; 2.83 g/100g of dietary fiber; 29.73 g/100g of carbohydrates and the caloric value of 129.62 kcal/100g of pulp. As for the content and profile of sugars in the pulp, 19.41 g/100g of fructose and 4.01 g/100g of glucose were obtained. The fruit had a high content of carotenoids (40 mg/100g on a wet basis), of which 89% was lycopene (36 mg/100g), 2.5 mg/100g of β-carotene and 0.3 mg/100g of lutein. Rutin was identified as a flavonoid present in the fruit pulp. The caferana fruit proved to be an excellent source of lycopene, with higher levels than tomato-based products.

RESUMO

O presente estudo teve como objetivo avaliar a qualidade nutricional do fruto de caferana, com foco no teor e perfil de carotenoides, devido à sua coloração característica desses compostos. Os frutos foram coletados, identificados botanicamente e avaliados quanto à composição centesimal, teor e perfil de carotenoides e de açúcares e perfil de flavonoides. Os resultados da composição centesimal da polpa de caferana foram: 65g/100g de umidade; 0,72g/100g de cinzas; 0,92g/100g de proteína; 0,78g/100g de extrato etéreo; 2,83g/100g de fibra alimentar; 29,73g/100g de carboidratos e o valor calórico de 129,62 kcal/100g da polpa. Quanto ao teor e perfil de açúcares na polpa, obteve-se 19,41g/100g de frutose e 4,01g/100g de glicose. O fruto apresentou alto teor de carotenoides (40mg/100g em base úmida), dos quais 89% era licopeno (36mg/100g), 2,5mg/100g de β-caroteno e 0,3mg/100g de luteína. Identificou-se a rutina como flavonoide presente na polpa do fruto. O fruto da caferana revelou-se uma excelente fonte de licopeno, com teores superiores aos produtos à base de tomate.

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Introduction

The species *Bunchosia armeniaca* (Cav.) DC., popularly known as caferana, cafezinho, plum, ciruela, caramela, is an exotic plant, cultivated in Brazil for many years, but only in domestic orchards. Native to several Andean countries in altitude areas between 1500 and 2400 m. It is a small evergreen tree 2 to 5 m tall. The leaves are simple, with a cartaceous blade and pubescent when young, from 10 to 17 cm in length. Its flowers are androgynous and slightly fragrant, appearing mainly in spring and arranged in axillary clusters up to 10 cm long. The fruits ripen during the summer and have a thin, fleshy endocarp (pulp), with a sweet taste and containing a single seed (Lorenzi et al., 2006). The popular name in English is "peanut butter fruit", since the pulp, when ripe, has a consistency and aroma similar to peanut butter.

The oblong, red, smooth, drupe-like fruits with fine, yellowish-red, juicy and sweet pulp usually containing two greenish seeds (Kinupp & Lorenzi, 2014) draw attention for their color, as they are a possible source of carotenoids.

Interest in the fruits of Brazilian biodiversity has increased, due to their potential to promote health benefits. Such effects are attributed to bioactive compounds, among them carotenoids can be mentioned. Brazil has a wide variety of foods rich in carotenoids, especially fruits and vegetables.

Carotenoids are remarkable compounds for having a wide distribution in nature, diverse chemical structures and varied functions. Although carotenoids are micronutrients, present at very low levels (micrograms per gram), they are among the most important food constituents. They are natural pigments responsible for the yellow to orange or red colors of many fruits, vegetables, egg yolks, cooked crustaceans, and some fish. They are also bioactive compounds, with beneficial effects on health, and some of them have pro-vitamin A activity (Rodriguez-Amaya et al., 2008).

Lycopene is the first carotenoid to accumulate, after absorption, in human tissues and fluids, such as the prostate and blood serum, respectively. Serum concentrations, however, vary widely between individuals (Bramley, 2000). It has been suggested that the mode of action of lycopene in the prevention of cardiovascular diseases is related to its antioxidant properties, leading to the protection of lipoproteins against oxidation.

Lycopene has been identified as the carotenoid responsible for reducing the risk of prostate cancer among men. According to data from the Brazilian National Cancer Institute (INCA, 2019), prostate cancer is the second most common cancer among Brazilian men. The number of deaths in 2019 was 15,983 and the estimate of new cases for 2020-2022 was 65,840 representing 29.2 % of the cancer incidence in men (INCA, 2019).

Some studies highlight the biological potential of *Bunchosia armeniaca*. Abbas et al. (2022) studied the *B. armeniaca* leaves metabolites, analyzed using Quadrupole-Time-of-Flight-Liquid-Chromatography-Mass Spectrometry (Q-TOF LC/MS/MS), to investigate the neuroprotective effect of the plant in induced Alzheimer's disease model. The study highlighted the possible novel potential of *B. armeniaca* in preventing memory impairment, possibly through its antioxidant effect and inhibition of acetylcholinesterase, inflammatory and oxidative stress mediators.

B. armeniaca fruit presented a broad spectrum of medicinal properties as antimicrobial, antioxidant and anti-inflammatory activities (Premathilaka and Silva, 2016). *B. armeniaca* fruits were analyzed using gas chromatography with mass spectrophotometer (GC-MS) to investigate its phytochemical availability. Authors reported the presence of many bioactive constituents as alkaloids, important fatty acids and some other biologically active compounds. DPPH assay and total phenolic content showed its antioxidant potential.

Few studies were found in the literature on the chemical constitution of the fruits of the *Bunchosia armeniaca* species. According to Kinupp and Lorenzi (2014), it is a species that has been poorly studied chemically and bromatologically, although it is a promising source of carotenoids and substitute for tomato sauce. The objective of the present study was to evaluate the nutritional quality of these fruits, focusing on the content and profile of carotenoids due to the characteristic coloration of these compounds.

Material and methods

For the botanical identification of the species, specimens were prepared and deposited in the Herbarium of the Botany Department of the Federal Rural University of Rio de Janeiro - RBR (Rio de Janeiro, RJ, Brazil) – specimen number RBR 35799.

The fruits were harvested in the West Zone of the city of Rio de Janeiro, RJ, Brazil (22°57'50"S 43°23'4"W). Harvesting was carried out at the end of fruit maturation, characterized by orange to red color (Figure 1). As it is a climacteric fruit and matures unevenly in the plant (Kinupp & Lorenzi, 2014), the fruits were kept in plastic packaging at room temperature to complete the maturation process, which took an average of 12 hours. To perform the analyses, the pulp was manually separated from the seeds and weighed in triplicate. All analyses were performed in triplicate.

Figure 1.

Branches with fruits and maturation stages of caferana fruits.

The proximate composition of the pulp was determined according to methods from the Association of Official Analytical Chemists (AOAC, 2005): moisture (934.06), ash (923.03), ether extract (945.38), total nitrogen/protein (2001.11 modified) and dietary fiber (985.29). The carbohydrate content and the caloric value were calculated according to Resolution RDC number 360 of December 23, 2003 (Brazilian Health Regulatory Agency [ANVISA], 2003). The total caloric value corresponds to the sum of protein, fat and carbohydrate caloric values.

Carotenoids were extracted from the samples with cold acetone, followed by partitioning into petroleum ether (Rodriguez-Amaya, 2001). Subsequently, they were concentrated by evaporating the solvent to dryness under nitrogen flow and diluted in acetone. Chromatographic analysis was performed under the following conditions: chromatographic column (YMC Carotenoid 3 µm 4.6 x 250 mm) at 33°C, mobile phase elution in gradient mode from methanol: methyl tert-Butyl ether (80:20 v/v) to (10:90 v/v) in 28 minutes with a flow rate of 0.8 mL/min and detection in a Photodiode Array Detector (PDA) at 450 nm (Pacheco et al., 2014).

The analysis of sugars by high performance liquid chromatography (HPLC) was performed according to Macrae (1998). Two grams of pulp were weighed for extraction in ultrapure water obtained through the Milli-Q system (Millipore, USA) in an ultrasonic bath for 20 minutes. The supernatant was filtered for analysis. The chromatographic conditions were: isocratic elution in acetonitrile: water (75:25 v/v), Zorbax carbohydrate column (5µm, 4.6 x 250 mm) and detection was performed in a refractive index detector.

For the qualitative analysis of flavonoids, extraction was performed with methanol: water (80:20 v/v) kept at 65°C for 2 hours and 30 min. Subsequently, 600 µL of 2 M NaOH was added, which after vigorous stirring was maintained at rest at room temperature for 10 minutes. Then, 200 µL of Glacial Acetic Acid was added and kept at room temperature until

the solid material had decanted (AOAC, 2005). The supernatant was transferred to a vial for chromatographic analysis, under the following conditions: Thermo BDS HYPERSIL C18 column (100 x 4.6 mm; 2.4µm) in an oven at 45 ºC, PDA Scanner Detector 210 at 600 nm with quantification at 260nm, injection volume of 10 µL, gradient elution 1 % formic acid in water:acetonitrile (95:5 v/v) to (40:60 v/v) for 23 minutes with flow rate of 1 mL/min.

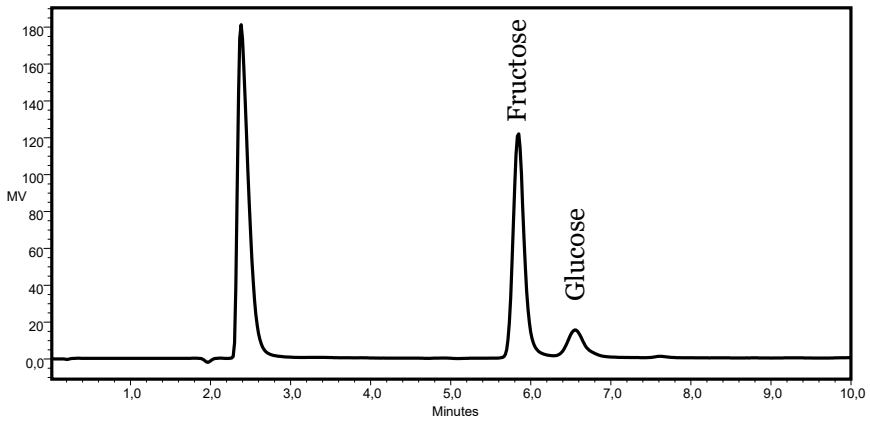
Results and discussion

The results of the proximate composition of the caferane pulp were: 65 g/100g of moisture; 0.72 g/100g of ash; 0.92 g/100g of protein; 0.78 g/100g of ethereal extract; 2.83 g/100g of dietary fiber; 29.73 g/100g of carbohydrates and the total caloric value of 129.62 kcal/100g of pulp.

The content and profile of sugars in the pulp (Figure 2) obtained were 19.41 g/100g of fructose and 4.01 g/100g of glucose. Sucrose was not detected. Therefore, considering the total of 29.73 g of carbohydrates per 100 g of pulp, 78% (23.42 g) consisted of reducing sugars.

Figure 2.

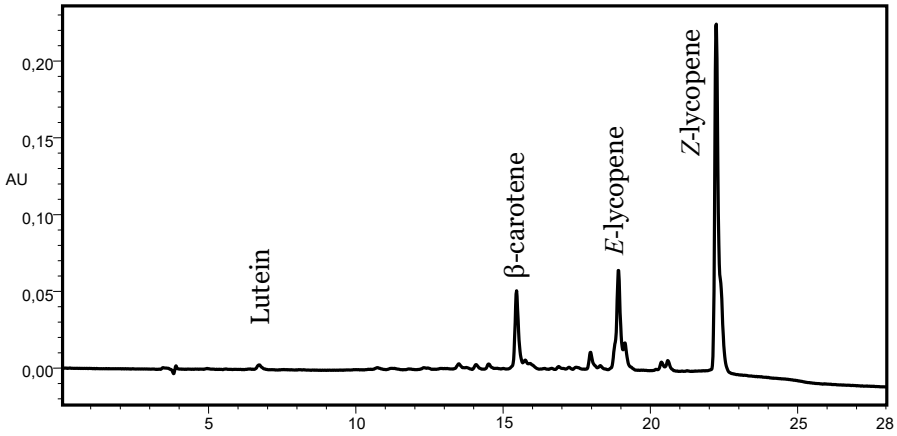
Chromatogram of sugar analysis from caferana pulp.



The caferana pulp had a high content of carotenoids (40 mg/100g on a wet basis), of which 89 % was lycopene (36 mg/100g), the remaining 2.5 mg/100g was β-carotene, and 0.3 mg/100g lutein. Figure 3 presents the chromatogram of the carotenoid analysis. The fruit proved to be a rich source of lycopene, since it presented a content 10 times higher than that of tomato (3.5 mg/100g). Compared to processed tomato-based products, the lycopene content of caferana pulp is still higher, since in the Brazilian table of carotenoid composition in foods (Rodriguez-Amaya et al., 2008), they recorded the following values for lycopene: 15.5 mg/100g ketchup; 23.5 mg/100g of tomato extract; 10.0 mg/100g of tomato sauce, 12.0 mg/100g of tomato puree.

Figure 3.

Chromatogram of carotenoid of caferana fruit pulp.



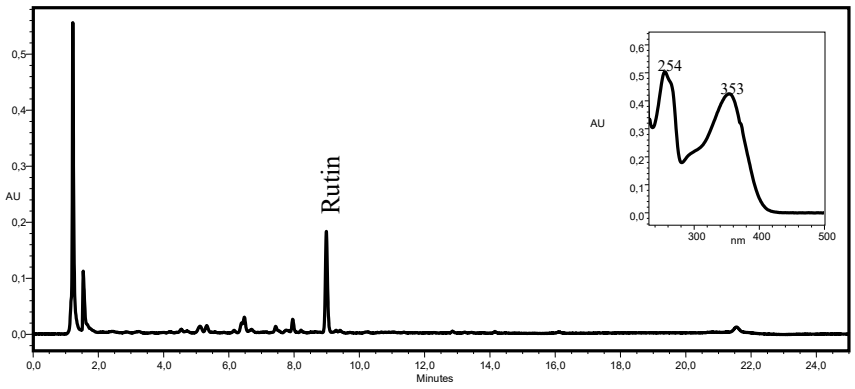
Considering that tomatoes and their products are the main sources of lycopene in the Western diet, the content of this carotenoid in caferana draws attention due to its potential for use, since it is a fresh fruit. Lycopene is the carotenoid with the highest antioxidant activity and is present in high concentration in prostate tissue, which may explain its role in reducing the risk of prostate cancer.

Blank et al. (2018) evaluated *Bunchosia glandulifera* fruits (species of the same genus Bunchosia) at different stages of maturation. They verified an increase in the content of bioactive compounds in the ripe fruits. The carotenoid content showed a positive correlation with the antioxidant activity. Colorimetric analysis also showed a high correlation between carotenoid levels and color change during the maturation phases. The results suggest that the fruit should be consumed when it is fully ripe (red), since it has higher levels of nutrients and bioactive compounds.

The presence of rutin (Figure 4) can be highlighted in the caferana fruit, a flavonoid that has important antioxidant activity *in vivo* (Rodrigues et al., 2003). In a study carried out with the crude extract of *Bunchosia armeniaca* leaves, Queiroz (2012) obtained the flavonoid profile composed of rutin (83.48%), afzelin (10.95%) and isoquercitrin (5.57%). Xu et al. (2020) carried out metabolomic analysis of acerola fruit (*Malpighia emarginata*), another species of Malpighiaceae family, and identified rutin among the six major phenolic compounds in ripe fruits.

Figure 4.

Chromatogram of flavonoids analysis from caferana pulp and UV spectrum of rutin.



Conclusions

The caferana fruit is an excellent source of lycopene, containing higher levels than tomato-based products. It has good potential for cultivation, presenting good productivity in domestic orchards, practically without cultural treatments. It also draws attention for its potential for use, for its flavor and texture for consumption *in natura*, and part of culinary preparations designed to increase the levels of lycopene in the diet.

Considering that the results indicated the functional potential of the *B. armeniaca* fruits, future works could evaluate the bioavailability of carotenoids, focusing on lycopene. Studies on the biological activity of the fruit pulp can contribute to its use as a functional food.

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REFERENCES

Abbas, H.A., Salama, A.M., El-Toumy, S.A., Salama, A.A.A., Tadros, S.H. & El Gedaily, R.A. (2022). Novel Neuroprotective Potential of *Bunchosia armeniaca* (Cav.) DC against Lipopolysaccharide Induced Alzheimer's Disease in Mice. Plants, 11, 1792. https://doi.org/10.3390/plants11141792

Agencia Nacional de Vigilância Sanitária. (2003). *Resolução RDC nº 360, de 23 de dezembro de 2003. Regulamento Técnico sobre Rotulagem Nutricional de Alimentos Embalados, tornando obrigatória a rotulagem nutricional.* Diário Oficial da União, Poder Executivo.

Association of Official Analytical Chemists. (2005). *Method 2001.10. Determination of isoflavones in soy and selected foods containing soy*. Official Methods of Analysis of AOAC International.

Blank, D.E., Justen, D., Fraga, S., Peixoto, C.R. & Moura, N.F. (2018) Chemical Composition and Antioxidant Activity of Bunchosia glandulifera Fruit at Different Ripening Stages. Food and Nutrition Sciences, 9, 1147-1159. https://doi.org/10.4236/fns.2018.910083

Bramley, P.M. (2000). Is lycopene beneficial to human health? *Phytochemistry*, 54 (3), 233-236.

Instituto Nacional de Câncer. (2019). *Estimativa 2020: incidência de câncer no Brasil*. INCA. https://www.inca.gov.br/sites/ufu.sti.inca.local/files/media/document/estimativa-2020-incidencia-de-cancer-no-brasil.pdf

Kinupp, V. F., & Lorenzi, H. J. (2014). *Plantas alimentícias não convencionais (PANC) no Brasil: guia de identificação, aspectos nutricionais e receitas ilustradas*. Instituto Plantarum de Estudos da Flora.

Lorenzi, H., Bacher, L., Lacerda, M., & Sartori, S. (2006). *Brazilian fruits & cultivated exotics (for consuming in natura)*. Instituto Plantarum de Estudos da Flora.

Macrae, R. (1998). *Food Science and technology – A series of monoghraphys: HPLC in food analysis*. (2nd ed). Academic Press.

Pacheco, S., Peixoto, F.M., Borguini, R.G., Nascimento, L.S.M., Bobeda, C.R.R., Santiago, M.C.P.A., & Godoy, R.L.D.O. (2014). Microscale extraction method for HPLC carotenoid analysis in vegetable matrices. *Scientia Agricola*, 71, 416-419.

Premathilaka, U.L.R.R., & Silva, G.M.S.W. (2016). Bioactive compounds and antioxidant activity of Bunchosia Armeniaca. World Journal of Pharmacy and Pharmaceutical Sciences, 5 (10), 1237-1247.

Queiroz, G. S. (2012). Flavonoides de *Bunchosia armeniaca* e derivados de 2-arilideno-1-a-tetralona: obtenção e atividades biológicas. [Dissertação de mestrado, Universidade Federal de Santa Catarina]. Repositório Institucional da UFSC.

Rodrigues, H. G., Diniz, Y. S. A., Faine, L. A., Almeida, J. A., Fernandes, A. A. H., & Novelli, E. L. B. (2003). Suplementação nutricional com antioxidantes naturais: efeito da rutina na concentração de colesterol-HDL. *Revista de Nutrição*, 16, 315-320.

Rodriguez-Amaya, D.B.; Kimura, M., & Amaya-Farfan, J. (2008). *Fontes brasileiras de carotenoides: tabela brasileira de composição de carotenoides em alimentos*. Ministério do Meio Ambiente/Secretaria de Biodiversidade e Floresta.

Rodriguez-Amaya, D. B. (2001). *A guide to carotenoid analysis in foods*. ILSI Press.

Xu, M., Shen, C., Zheng, H., Xu, Y., Xue, C., Zhu, B., & Hu, J. (2020). Metabolomic analysis of acerola cherry (*Malpighia emarginata*) fruit during ripening development via UPLC-Q-TOF and contribution to the antioxidant activity. Food Research International, 130, 108915. https://doi.org/10.1016/j.foodres.2019.108915