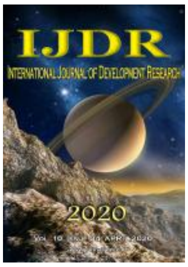
ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 11, Issue, 03, pp.45649-45654, March, 2021
https://doi.org/10.37118/ijdr.21442.03.2021



RESEARCH ARTICLE

OPEN ACCESS

CAGAITA PULP (*EUGENIA DYSENTERICA* DC): EXTRACTION TECHNOLOGY AND PHYSICAL-CHEMICAL CHARACTERIZATION

***Adriana R.Machado, Jeisa F. de Sousa Santana, Jéssica S. Medeiros, Lorrane S. dos Santos, Glenda Antonia da R. Neves, Fabiano G. Silva and Letícia F. Viana**

Federal Institute of Education, Science and Technology Goiano, Rio Verde, GO, Brazil

ARTICLE INFO

Article History:
Received 25th January, 2021
Received in revised form
17th January, 2021
Accepted 20th February, 2021
Published online 30th March, 2021

Key Words:

Fruit, Cerrado, Processing, Minerals,
plant-Based Ingredient.

****Corresponding author:***
Heiko Thereza Santana

ABSTRACT

The cagaita (*Eugenia dysenteric* DC) is a native fruit from Cerrado with a globose shape, light yellow color, and slightly acidic taste. Besides having functional properties, making it is widely used in chronic constipation treatments. It is a fruit with a unique flavor and can be used in agro-industries in ice cream, jams, jellies, juices, and the like. This work's objective was to present the technology used in extracting of fruit pulp from Eugenia desynterica DC since harvest time until the storage process and its physicochemical characterization. The following activities were performed: technology used in the process of extracting the pulp until it was frozen (right after extraction), physically and chemically characterized about the total soluble solids (ss), pH, total titratable acidity, moisture, protein, as well as carotenoid analysis, minerals and determination of the colorimetric parameters. According to the results, it can be stated that fruit characteristics are directly related to soil composition, climate, and genetic diversity. In this study, it can be concluded that the results obtained about all studied parameters agree with the literature.

Citation: *Adriana R.Machado, Jeisa F. de Sousa Santana, Jéssica S. Medeiros, Lorrane S. dos Santos, Glenda Antonia da R. Neves, Fabiano G. Silva and Letícia F. Viana.* "Cagaita pulp (*Eugenia Dysenterica DC*): extraction technology and physical-chemical characterization*", International Journal of Development Research*, 11, (03), 45649-45654.

INTRODUCTION

The last year shows a overturn in the food market, bringing healthier and sustainable choices. The food industry is looking for raw materials with bioactive compounds and supporting small agro-food businesses **(**Borsellino, Kaliji, Schimmenti, 2020). In this sense, the Cerrado biome (Fig. 1) offers a wide diversity in its flora, including native fruits with peculiar sensory and nutritional characteristics and with great potential for technological use, which is traditionally consumed and marketed in nature or the form of sweets, juices, ice creams, and liquors (Alves, 2013). The native fruits of the Cerrado have sugars, vitamins, proteins, and minerals, besides having a characteristic taste, contributing to prospects for agro-industrial purposes (Pinto, 2006). Among the numerous fruit species that characterize the Cerrado, there is the cagaiteira (*Eugenia dysenteric* DC.). Its fruits may present equivalent or superior B vitamins to those found in fruits traditionally considered a good source of these vitamins, such as guava, banana, and avocado. Cagaita is known in central-western Brazil, Mato Grosso and Goiás (Vera et al., 2005). It is a slow-growing, medium-sized fruiting tree (Bessa et al., 2020; Camilo et al., 2014). The fruit (cagaita) is a yellow-colored globular fruit containing one to three white seeds, covered by a slightly acidic pulp. Besides its unique flavor, the pulp of this fruit has a low energy value (29.83 kcal.100g-1), contains 34 mg.100g-1 of vitamin C (Cardoso et al., 2011), and a total phenolic compound content of 111 mg AGE.100g-1(Rocha et al., 2011). In folk medicine, cagaita pulp is widely used in the treatment of chronic intestinal colds due to its laxative properties (Alves, 2013; Lima et al., 2010).The knowledge of the physical characteristics of the fruits is essentialto know the diversity of size and mass in each species and to make possible create a package for storage, marketing (Rocha et al., 2013) and also to enable the food industry to use this fruity as an ingredient, thus contributing to the preservation of Cerrado biome. As this fruit is still obtained mainly by extractivism, this paper aims to present technology for pulp extraction from cagaita fruit, its harvest to the storage process, and its physical and chemical characterization.

Source: IBGE, 2015.

Figure 1: Representative map of Brazil's biomes

MATERIAL AND METHODS

The present research was characterized as a laboratory and qualitative study, with that the qualitative methods are those in which the interpretation by the researcher with his opinions about the phenomenon under study is essential, as well as the reflexive practice of social emphasis that is investigated and the process of investigation (Pereira et al., 2018).

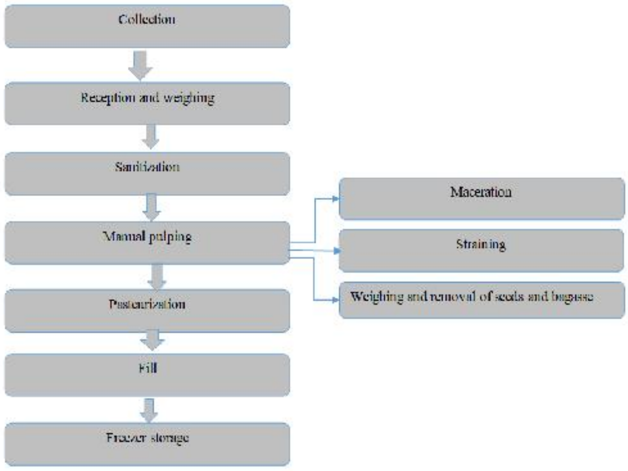
Stages of Cagaita processing: The fruits of cagaitera (*Eugenia dysenteric* DC), shown in Figure 2, came from natural unplanted vegetation organized in the region of Montes Claros de Goiás (16º06'20" S and 51º17'11" W), harvested manually from September to October 2016 and immediately transported to the Laboratory of Plant Culture and Tissues (LCTV) at the Federal Institute Goiano Campus Rio Verde, where they were prepared, stored, and evaluated. As soon as the fruits arrived at LCTV - Food Biotechnology, they were weighed for better control over the existing amount of samples. Soon after, they were sanitized (left for 15 minutes in a solution of sodium hypochlorite at 200 ppm). Later, they were manually pulped (macerated and separated from the shells and seeds).

At this stage, there was the separation of any material that was not the fruit's pulp after separately sifting and weighing the seeds and the bagasse. Pasteurization was then carried out in a water bath at 80 °C for 20 minutes. After this stage, the filling was carried out. In this case, it consisted of storing the pulp in thermoplastic polypropylene packages. The packages containing the pulps were taken to the ultra-freezer of the ColdLab brand at -80ºC (fast freezing) because it is the ideal temperature to avoid the loss of bioactivity compounds in the material and prevent the formation of ice crystals, thus preserving the characteristics of the samples and avoiding the appearance of considerable changes when performing the analyses. Figure 3 presents the flowchart representation of the pulp extraction technology from the kite to freezing.

Physical Analysis: The characteristics, such as diameter and length, were determined with a digital 150 MM stainless steel pachymeter. To obtain the mass, an analytical balance Gehaka AG200 was used.

Source: Authors, 2017.

Figure 2: Cagaita (*Eugenia Dysenterica*).



Source: Authors, 2017.

Figure 3. Shows the pulp stored in plastic containers (polystyreneatotoxic)

The measurements were performed with eleven samples where they were divided into five groups with three samples in each, but one sample in each group was excluded to improve the standard deviation, thus ending with ten samples in total and five groups with two samples in each, at the end presenting their respective mean and standard deviation.

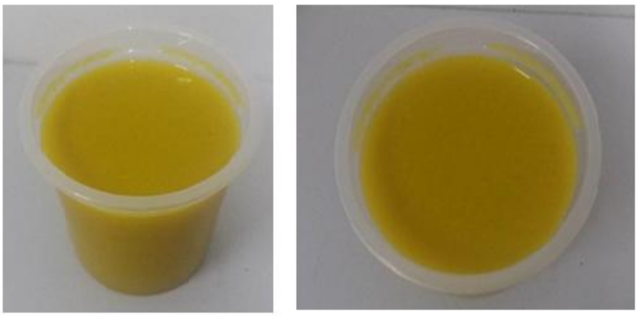
Physical-Chemical Characterization: The following determinations were made on the shell and pulp of the kite:

Total soluble solids (SS)- Determined by direct reading using the digital refractometer corrected for a temperature of 20 °C, values expressed in °Brix (Lutz, 2008).

pH- Determined by Digimed potentiometer - DM-20, with the sample at a temperature of 20°C. According to the methodology described by the Adolfo Lutz Institute (2008).

Total titratable acidity (ATT)- Volumetric method, by titration with NaOH 0.1N, the results being expressed in % citric acid (Lutz, 2008).

Humidity: A crucible, previously weighed, and with about 5 g of shell and pulp, separated and coded, was taken to the oven at a temperature of 105º C, for approximately 2 days and after being removed from the oven, it was taken to the desiccator for about 2 hours, according to AOAC cited by Horwitz & Latimer (2005).



Source: Authors, 2017.

Figure 4. Pulp obtained from the Eugenia dysenteric

The final value of the humidity is defined by the following Equation (1):

$$Humidity\,(\%) - 100 - \left(Mcs - \frac{Mc}{Ms}\right) Humidity\,(\%) - 100 - \left(Mcs - \frac{Mc}{Ms}\right) * 100$$

Where: MCs represent the crucible mass + sample after drying, MC represents the crucible mass after drying, and Ms the initial mass of the sample.

Protein: The method used was Kjeldahl referenced by the AOAC (Association of Official Analytical Chemists), which determines the crude protein by quantifying the protein nitrogen content and not the total protein (AOAC, 2007). All analyses were performed in triplicate, and the results were expressed in grams of protein per 100 g of sample ($g.100g^{-1}$).

Carotenoid Analysis: The carotenoid contents were determined by the methodology of (Rocha et al., 2013). The procedure consisted of wrapping the test tubes with aluminum foil, then weigh 2g, 5g, and 10g of the sample in each tube, place 20 ml of the acetone-hexane mixture in the proportion (4:6), shake for 10 minutes in a tube shaker and then filter with becker filter paper protected with aluminum foil, where the following wavelengths were read in the Shimadzu 1800UV spectrophotometer: 453 nm, 505nm, 645nm, and 663nm. The white one was also performed, which consists only of the acetone-hexane mixture. The reading was done in a dark environment. The analysis was done in triplicate for each concentration. Equation (2) was used to calculate the content of β carotene (in $mg.100\ mL^{-1}$):

$$\beta - carotene \left(\frac{mg}{100}g\right) = (0{,}216 * A663 - 1{,}22 * A645 - 0{,}304 * A505 + 0{,}452 * A453$$

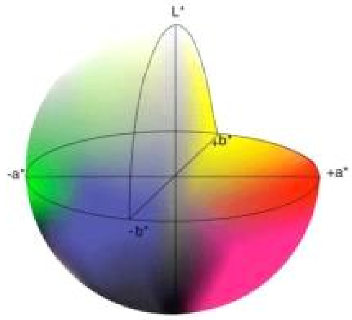
The results were expressed in mg β carotene / 100 g^{-1} of the fresh sample.

Determination of Minerals: The fruit's minerals were analyzed in an atomic absorption spectrometer, SpectrAA 110 Varian model at Solotech Cerrado Laboratory, Rio Verde Goiás. According to the AOAC 997.15 and the 990.8 methods (AOAC, 2010). Results were expressed in $mg.100\ g^{-1}$.

Determination of colorimetric parameters: The colorimetry was determined at 25ºC, using a digital calorimeter (Minolta CR4000, D65 light source in color space L* a* b* of CIE system L*a*b), with calibration with a standard white plate, following the manufacturer's instructions (Minolta, 2001).

The results were expressed in L* (brightness) ranging from 0 (black) to 100 (white); a* ranging from -a* (green) to +a* (red) and b* from -b* (blue) to +b* (yellow) according to the methodology described in the Adolfo Lutz Institute's analytical standards (2008). These parameters can be seen more clearly in Figure 5.

Analysis of data: All results were expressed as mean (n=3) and standard deviation.



Source: Minolta, 2001.

Figure 5. Colorimetric parameters

RESULTS AND DISCUSSION

The physical characteristics of the cagaita fruits are presented in Table 1. The length (26.90±1.73), diameter (29.15±1.95), the ratio between then (0.92±0.034), and the mass (12.37±1.77) were lower than those found by Camilo et al. (2014) and similar to Filho (2016). In Silva (2016), the relationship between the fruit's physical and physiological aspects was verified, and the development of the fruit and how it behaves during the fruiting stage was presented.

Table 1. Physical analysis of cagaita fruits (*Eugenia dysenteric* DC)

Analysis	Values
Length (mm)	26.90±1.73
Diameter (mm)	29.15±1.95
L/D (mm)	0.92±0.034
Mass (g)	12.37±1.77

Source: Authors

Table 2. Physical and chemical characterization of Cagaita (*Eugenia dysenteric* DC) shell and pulp

Analysis	Cagaita pulp (fruit)
Soluble solids (°Brix)	10,0 ± 0.11
pH	4.30±0.16
Acidity (citric acid $g.100g^{-1}$)	0.78±0.02
Moisture(%)	86.61±0.21
Ash(%)	5.04±0.09
Lipids(%)	13.96±0.32
Protein ($g.100g^{-1}$)	1.16±0.24
β-carotene (mg. $100g^{-1}$)	135.47±5.60

Source: Authors

The characteristics of the fruit are directly related to soil composition, climate, and genetic diversity. According to Filho (2016), the shape of the fruit is related to longitudinal and transverse diameter (LD/DT), also called length and diameter; thus, fruit with values close to 1(µM) is round. According to the Adolfo Lutz Institute (2008), soluble solids, content aims to determine the concentration of soluble solids in aqueous sugar solutions. According to Normative Instruction No. 37(BRAZIL, 2018), the content of soluble solids (°Brix) varies from 5.5 to 11.0 °Brix, and this value depends on the fruit that gave rise to fruit pulp. In Table 2, the values are within the legislation. Bueno et al. (2017) obtained results of 7.75, 9.17, and 10.67 for the fruits of Cagaitera (Eugenia dysenteric) in the municipalities of Caetanópolis (Ca), Paraopeba (Pa), and Prudente de Moraes (Pr), respectively, compared to this study. The pH found in this study was 4.30, according to Silva et al. (2019), in their research with cagaitas from different micro-regions of Minas Gerais, found pH: 3.18 and SS:9.56 in the micro-region of Peroba, 3.06 and SS:8.69 in Sete Lagoas and 3.24 and SS:8.23 in Prudente de Morais. Being these values lower than this study. According to the authors, these differences can be justified by the mode of production and soil type of each region.

Table 3. Micronutrient and macronutrient levels in Cagaita pulp (Eugenia dysenterica DC)

	Cagaita (*Eugenia dysenterica DC)*					
Macronutrients (g/kg)*	N	P	K	Ca	Mg	S
	70.3±1.470	0.47±0.010	0.48±0.010	0.05±0.006	0.12±0.012	1.08±0.015
Micronutrients (mg/kg)*	Fe	Mn	Cu	Zn	B	-
	5.2±0.050	1.2±0.050	0.5±0.050	3.73±0.160	0.91±0.108	-

*Values expressed in mean ± standard deviation format. Source: Authors

The natural consumption population accepts more fruits that present a higher SS/AT ratio. They present higher soluble solids content and lower acidity content, therefore sweeter and less acidic (Camilo et al., 2014). The higher the amount of NaOH spent in the analysis, the higher the sample's acidity. The value obtained of 0.78% of the pulp's acidity in nature differed from those found by Miyazawa (2009) and Zillo et al. (2013), which brought 1.08% and 1.05%, respectively. The drop in brightness during the pulp storage at a temperature of approximately 8 - 10°C favors the decrease in acidity, but not totally, because there is a deterioration of the fruit over the days through the action of enzymes, justified by the high humidity of the fruit and, therefore, there is an increase in acidity (Costa et al., 2003). The analyses showed that the pH and total acidity values in citric acid in the pulp are within the identity and quality standard (BRAZIL, 2018). Thus, according to Lima et al. (2015) and Bueno et al. (2017), the pH measurement is an essential parameter in the analysis of industrialized food made from fruits since it is related to the retention of flavor-odor of fruit products, the stability of artificial colorants in them and the verification of the state of ripeness of fruits. The content of organic acids in fruits varies according to species. Their content decreases with ripeness in most tropical fruits due to their use in the Krebs cycle or their transformation into sugars during the respiratory process (Lima et al., 2015). In Brazilian legislation, only the minimum titratable acidity content is controlled for the flavors of the pulp analyzed, ranging from 0.30 to 0.90 % (BRAZIL, 2018). Based on the value shown in Table 2, it is within the norms of current legislation, with the result obtained being 0.78%.

Table 4. Determination of colorimetric parameters

Analysis	Results*
L	74.15±2.48
a*	-3.96±1.59
b*	65.63±1.65
c*	65.75±1.68
ºh	93.70±1.49

*Mean Analysis ± Standard Deviation Source: Authors.

Thus, pH and acidity are essential parameters in food conservation and are directly related to microbial activity control. Based on the results obtained in the cagaita pulp's humidity analysis, an average of 86.61% was obtained (Table 1). This value is close to those found in the literature, which presents an average humidity of 90.9%, according to Rocha et al. (2013). Cagaita has a high nutritional value and contains high water content (being on average 95.01%) (Almeida, 1998). The results found for Cagaita pulp (Eugenia dysenteric DC) about carotenoid content was 135, 37 mg. 100g-1 (Table 2). Comparing these results with the one found in a study by Cardoso et al. (2011) obtained a total content of 0.77mg of carotenoids per $100g^{-1}$ of pulp in their analyses. Carotenoids are pigments responsible for the yellow color and have an unstable chemical structure, easily reactive (Duarte et al., 2017). However, Biazotto et al. (2019) found in their research higher values (269.96 mg.100g-1) than this study for cagaita. Moreover, there are few studies of carotenoids forthe fruits of the cerrado. Studies indicate that carotenoids' antioxidant function plays an essential role in reducing the risk of cancer, cataracts, arteriosclerosis, and the aging process (Filho, 2008). The nutrients present in this study are essential for the development of the fruit: According to Silva et al. (2008), nitrogen maintains the productivity, improves the thickness of the peel and the acidity of the fruit; potassium maximizes the size and filling of the fruit, the productivity, quality of the peel and vitamin C content and reduces granulation and cracks in the fruit; calcium boosts leaf growth and vigor of the tree and reduces tissue disorders, including cracks and albedo collapse; magnesium maintains the filling, size, and condition of the fruit; zinc maintains fruit quality. Copper prevents fruit fragility; manganese and boron maintain fruit productivity (Silva et al., 2008). According to Guedes et al., (2017), green cagaita fruits provide the equivalent of 55.5% of the daily boron requirement, showing that it is rich in this nutrient, while ripe fruits provide 16.6% of the daily requirement, being the source of this nutrient. The consumption of boron is of great importance for humans because the consumption of boron brings beneficial effects to the central nervous system, acts to reduce some types of cancer, has a hormonal function, helps in the absorption of vitamin D and in the production of insulin, in addition to preventing and reducing arthritis (Nielsen, 2014). As can be seen in Table 3, the macronutrient found mainly in the fruit of cagaita was nitrogen and the micronutrient iron, an essential mineral essential for the functioning of the human body, an energy supplier which helps in the prevention of anemia, among several other benefits, and the value found for iron correlates, approximately, with the value of Silva et al. (2008). The minerals present in the cagaita bring benefits to health, such as regulating the metabolism of various enzymes, helping the acid-base balance, helping to regulate osmotic pressure, muscle, and nerve activity, facilitating the transfer of essential compounds across the membranes. In some cases, minerals are part of the constituent elements of tissue and are necessary for the vital process and must be contained in food in appropriate quantities and proportions (Ross et al., 2014). The fruit, cagaita, contains a considerable percentage of polyunsaturated fatty acids such as linoleic (10.5%) and linolenic acid (11.86%). These levels are above those of corn, sunflower, peanut, soybean, olive, and palm oils. Considering that fatty acids are essential substances in cell membrane structures, brain structure components, reproductive system, and retina, cagaita, therefore, enriches its consumers' diet, offering considerable nutritional benefits (Almeida, 1998). The fruit color analyses are shown in Table 1. The value of L gives us the luminosity, varying from white (L=100) to black (L=0), the a* coordinate can assume values from -80 to +100, where the extremes correspond to green and red, respectively; and the b* coordinate corresponds to the intensity of blue to yellow, which can vary from -50 (totally blue) to +70 (totally yellow) (Harder et al., 2007). In this study, the low a* and high b* values presented in Table 4 characterized the predominance of the yellow color of the fruit. Colour is the first criterion used to accept or reject the consumer's product, so color is an essential attribute in the food industry (Batista, 1994). About the light value of the color, the fruit showed lighter colors close to pure white. The saturation values (C*) were high and the values obtained for the color angle (H*) were higher than the other parameters evaluated, thus the product is characterized by yellow. The hue angle (h°) is represented by an angle of 0° to 360° degrees. Angles between 0° and 90° are represented by the reds, oranges, and yellows; from 90° to 180° are the yellows, yellow-greens, and greens; 180° to 270° are the greens, blue-greens, and blues; from 270° to 360° are the blues, purples, magentas and again the reds (Marques, 2008).

Final considerations: Therefore, it was verified that the fruits of cagaita in nature presented satisfactory physical-chemical characteristics, highlighting soluble solids' parameters, acidity, pH, and humidity, both according to the literature, with the characterization of cagaita, its potential as a promising source of compounds to be explored both in the food and in the pharmaceutical industry, thus presenting health benefits.

Acknowledgments: Technical contribution through the laboratories of IF Goiano and funders CNPq (Conselho Nacional de

Desenvolvimento Científico e Tecnológico), CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior– Brasil, FAPEG (Fundação de Amparo à Pesquisa do Estado de Goiás), IF Goiano.

Author contributions: ARM defined the structure of the paper and writing of the paper. JFS, LSS, JM and GAN contributed to the writing of the paper. FGS and LFV provided extensive feedback. All authors proofread and approved the submitted work.

Declaration of competing interest: The authors declare no competing interests.

REFERENCES

Almeida, S. P. de. 1998. *Frutas nativas do cerrado: Caracterização fisico-quimica e fonte potencial de nutrientes*. EMBRAPA-CPAC. p.247-285. http://www.sidalc.net/cgi-bin/wxis.exe/?Isis Script= ACERVO.xis &method=post&formato=2 &cantidad=1 & expresion=mfn=031944

Alves, A. M. 2013. *Caracterização física e química, compostos bioativos e capacidade antioxidante de frutas nativas do cerrado*. 65.

AOAC International, Horwitz, W., & Latimer, G. W. 2007. *Official methods of analysis of AOAC International*. Washington: AOAC International.

AOAC International, Horwitz, W., & Latimer, G. W. 2010. *Official methods of analysis of AOAC International*. Gaithersburg: AOAC International.

Batista, C. L. L. C. 1994. *Produção e avaliação da estabilidade de corante hidrossolúvel de urucum*. 71 p. 1. ed. Ed. UFLA.Brasil.

Bessa, L. A., Vitorino, L. C., & Silva, F. G. 2020. Micronutrient deficiency affects the development of the seedlings of the cagaita, a Myrtaceae typical of the Brazilian Cerrado. *Research, Society and Development*, *9*11, e65391110209–e65391110209. https://doi.org/10.33448/rsd-v9i11.10209

Biazotto, K. R., de Souza Mesquita, L. M., Neves, B. V., Braga, A. R. C., Tangerina, M. M. P., Vilegas, W., Mercadante, A. Z., & De Rosso, V. V. 2019. Brazilian Biodiversity Fruits: Discovering Bioactive Compounds from Underexplored Sources. *Journal of Agricultural and Food Chemistry*, *67*7, 1860–1876. https://doi.org/10.1021/acs.jafc.8b05815

Brazil. 2018. *Instrução Normativa n*[o] *37—Continuação—Imprensa Nacional*. Available at: https://www.in.gov.br/materia. Accessed on 20 January, 2020.

BorsellinO, V., Kaliji, S. A.& Schimmenti, E. 2020. COVID-19 drives consumer behaviour and agro-food markets towards healthier and more sustainable patterns. *Sustainability*, 1220, 8366-8370. https://doi.org/10.3390/su12208366.

Bueno, G. H., Guedes, M. N. S., Souza, A. G. de, Madeira, A. P. C., Garcia, E. M., Taroco, H. A., & Melo, J. O. F. 2017. Caracterização física e físico-química de frutos de eugenia dysenterica dc originados em região de clima tropical de altitude. *Revista brasileira de biometria*, *35*3, 515–522.

Camilo, Y. M. V., Souza, E. R. B. de, Vera, R., & Naves, R. V. 2014. Caracterização de frutos e seleção de progênies de cagaiteiras Eugenia dysenterica DC.. *Científica*, *42*1, 1–10. https://doi.org/10.15361/1984-5529.2014v42n1p1-10

Cardoso, L. de M., Martino, H. S. D., Moreira, A. V. B., Ribeiro, S. M. R., & Pinheiro-Sant'Ana, H. M. 2011. Cagaita Eugenia dysenterica DC. of the Cerrado of Minas Gerais, Brazil: Physical and chemical characterization, carotenoids and vitamins. *Food Research International*, *44*7, 2151–2154. https://doi.org/10.1016/j.foodres.2011.03.005

Costa, M. C., Maia, G. A., Souza Filho, M. de S. M., Figueiredo, R. W. de, Nassu, R. T., & Monteiro, J. C. S. 2003. Conservação de polpa de cupuaçu [Theobroma grandiflorum Willd. Ex Spreng. Schum] por métodos combinados. *Revista Brasileira de Fruticultura*, *25*2, 213–215. https://doi.org/10.1590/S0100-29452003000200007

Duarte, E. L., Carlos, L. A., Gonçalves, C. R., Andrade, R. M. de, & Oliveira, K. G. de. 2017. Influência da liofilização sobre os carotenoides de frutos do cerrado e comportamento higróscopico dos pós-liofilizados. *Biológicas & Saúde*, *7*23, Article 23. https://doi.org/10.25242/886872320171108

Filho, S. C. V. 2008. *Caracterização anatômica e histoquímica de folhas, calogênese e fitoquímica de calos de murici [Byrsonima verbascifolia L. Rich. Ex Juss]*. 82.

Filho, W. L. G. S. 2016. Caracterização física e química de frutos de cagaita Eugenia dysenterica. *Tecnologia & ciência agropecuaria*, *10*, 71–75.

Guedes, M. N. S., Rufini, J. C. M., Marques, T. R., Melo, J. O. F., Ramos, M. C. P., & Viol, R. E. 2017. Minerais e compostos fenólicos em diferentes estádios de maturação de frutos de cagaiteira Eugenia dysenterica. *Revista Brasileira de Fruticultura*, *39*1. https://doi.org/10.1590/0100-29452017360

Harder, M., Canniatti-Brazaca, S., & Arthur, V. 2007. Avaliação quantitativa por colorímetro digital da cor do ovo de galinhas poedeiras alimentadas com urucum Bixa Orellana. *Revista Portuguesa de Ciências Veterinárias*, *102*, 339–342.

Horwitz, W., & Latimer, G. W. 2005. *Official methods of analysis of AOAC International*. AOAC International.

Lima, T. B., Silva, O. N., Oliveira, J. T. A., Vasconcelos, I. M., Scalabrin, F. B., Rocha, T. L., Grossi-de-Sá, M. F., Silva, L. P., Guadagnin, R. V., Quirino, B. F., Castro, C. F. S., Leonardecz, E., & Franco, O. L. 2010. Identification of E. dysenterica laxative peptide: A novel strategy in the treatment of chronic constipation and irritable bowel syndrome. *Peptides*, *31*8, 1426–1433. https://doi.org/10.1016/j.peptides.2010.05.003

Lima, T. L. S., Cavalcante, C. L., Sousa, D. G. de, Silva, P. H. de A. e, & Sobrinho, L. G. A. 2015. Avaliação da composição físico-química de polpas de frutas comercializadas em cinco cidades do Alto Sertão paraibano. *Revista Verde de Agroecologia e Desenvolvimento Sustentável*, *10*2, 49-55.

Lutz, I. A. 2008. Métodos físico-químicos para análise de alimentos. *São Paulo: ANVISA*.

Marques, L. G. 2008. *Liofilização de frutas tropicais*. 255.Thesis.

Menezes Filho, A. C. P. de, Oliveira Filho, J. G., Christofoli, M., & Castro, C. F. de S. 2019. Atividade antioxidante e compostos bioativos em espécies de um fragmento de Cerrado goiano tipo cerradão. *Colloq. agrar.*, 1–8.

Minolta, K. 2001. *Comunicação Precisa Da Cor Konika-Minolta | Cor | Espectro Eletromagnético*. Scribd. https://pt.scribd.com/document/316786730/Comunicacao-Precisa-Da-Cor-Konika-Minolta. Japan.

Miyazawa, T. M. 2009. Compostos voláteis da uvaia Eugenia pyriformis cambess. *Aleph*, xi, 97 f. Master's Thesis.

Nielsen, F. H. 2014. Update on human health effects of boron. *Journal of Trace Elements in Medicine and Biology*, *28*4, 383–387. https://doi.org/10.1016/j.jtemb.2014.06.023

Pereira, A. S., Shitsuka, D. M., Parreira, F. J., & Shitsuka, R. 2018. *M*etodologia da pesquisa científica. Avalablein: https://repositorio.ufsm.br/bitstream/handle/1/15824/Lic_Computacao_Metodologia-Pesquisa-Cientifica.pdf?sequence=1.Acessed at: 23 February, 2020.

Pinto, P. C. R. 2006. *Consumo alimentar de frutos do cerrado, fontes de vitamina A, por moradoras de comunidades das cidades satélites do Distrito Federal*. 108. Avalablein: https://repositorio.unb.br/handle/10482/1977 Acessed at: 23 February, 2020.

Rocha, M. S., Figueiredo, R. W. de, Araújo, M. A. da M., & Moreira-Araújo, R. S. dos R. 2013. Physical and chemical characterization and antioxidant activity *in vitro* of fruit of the Piaui savanna. *Revista Brasileira de Fruticultura*, *35*4, 933–941.

Rocha, W. S., Lopes, R. M., Silva, D. B. da, Vieira, R. F., Silva, J. P. da, & Agostini-Costa, T. da S. 2011. Compostos fenólicos totais e taninos condensados em frutas nativas do cerrado. *Revista Brasileira de Fruticultura*, *33*4, 1215–1221. https://doi.org/10.1590/S0100-29452011000400021

Ross, C., Caballero, B., Cousins, R. J., Tucker, K. L., & Ziegler, T. R. 2014. *Nutrição Moderna de Shils Na Saúde e na Doença 11*[a] *Ed. - Baixar pdf de Docero.com.br* 11[a]. Manole. 1616. https://docero.com.br/doc/c1xsx

Silva, M. M. M. da. 2016. *Estudo do desenvolvimento fisiológico da cagaita Eugenia dysenterica*. http://repositorio.bc.ufg.br /tede/handle/tede/6789

Silva, M., Freitas, L., Souza, A., Araújo, R., Lacerda, I., Pereira, H., Augusti, R., & Melo, J. 2019. Antioxidant Activity and Metabolomic Analysis of Cagaitas Eugenia dysenterica using Paper Spray Mass Spectrometry. *Journal of the Brazilian Chemical Society*. https://doi.org/10.21577/0103-5053.20190002

Silva, M. R., Lacerda, D. B. C. L., Santos, G. G., & Martins, D. M. O. 2008. Caracterização química de frutos nativos do cerrado. *Ciência Rural*, *38*6, 1790-1793.

Vera, R., Naves, R. V., Chaves, L. J., & Leandro, W. M. 2005. Caracterização física de frutos do pequizeiro *Caryocar brasiliense Camb. no estado de Goiás*. Pesquisa Agropecuária Tropical, 35 2: 71-79.

Zillo, R. R., Silva, P. P. M., Zanatta, S., Carmo, L. F., & Spoto, M. H. F. 2013. Qualidade físico-química da fruta *in natura* e da polpa de uvaia congelada. Revista Brasileira de Produtos Agroindustriais, *15*3, 293–298. https://doi.org/10.15871/1517-8595/rbpa.

****