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BIOPROSPECTION OF MANGABA (*HANCORNIA SPECIOSA* Gomes) NATIVE IN THE TRANSITION REGION SAVANNA-RESTINGA

***,[1]Georgiana Eurides de Carvalho Marques, [2]Clenilma Marques Brandão, [3]Djanira dos Santos Rubim and [4]Juliane Cutrim Marques**

[1]Department of Chemistry, Federal Institute of Education, Science and Technology of Maranhão; [2] Department of Chemistry, Federal Institute of Education, Science and Technology of Maranhão; [3]Department of Chemistry, Federal University of Maranhão; [4]Department of Chemistry, Federal Institute of Education, Science and Technology of Maranhão

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Corresponding author: Georgiana Eurides de Carvalho Marques,

ABSTRACT

This research aimed to determine the chemical and antioxidant properties of mangaba fruits from the Savanna-Restinga region in the State of Maranhão. Ripe fruits from mangabeira matrices originating from naturally occurring areas were analyzed. Morphometric analyzes of length and diameter were performed on the fruits. In the chemical characterization, the contents of lipids, mineral residue, fibers, proteins, vitamin C, carbohydrates, starch, ºBrix, pH, ATT and minerals were investigated according to recommended methodologies. For bioactive compounds, levels of phenolic compounds, anthocyanins, flavonoids, carotenoids and antioxidant capacity were determined. The results both for the chemical composition and for its bioactivity confirmed its potential as a source of nutrients in food and for its medicinal use, characteristics that have been proven through the uses by traditional communities.

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INTRODUCTION

Mangaba (*Hancornia speciosa* Gomes) belongs to the Apocynaceae family, is an important fruit tree native to Brazil occurring in the coastal plains and plateaus of the Northeast, the Savanna of the Midwest, the North and Southeast regions of Brazil (DA SILVA *et al*., 2017). The plant is 2-15 m high, with an irregular crown, twisted branches and very rough trunks. The fruit is round or ellipsoid, measuring 2-6 cm, containing 2-25 seeds, with yellowish or greenish exocarp and red pigmentation or no pigmentation, with sweet and acid, yellow, smooth, sweet and fleshy-viscosa flesh. (LIMA *et al*., 2013; NASCIMENTO *et al*., 2014). The mangabeira has long been important for traditional medicine and for feeding traditional communities. Its medicinal properties in the literature are discussed in the treatment of diabetes, hypertension, inflammatory and infectious diseases (BARBOSA *et al*., 2019). In review studies by DE CARVALHO *et al*., (2019) showed that due to the presence of natural antioxidants, mangaba has the potential to destroy tumor cells and to protect healthy cells from damage caused by chemotherapy. In addition, the importance of the mangaba fruit is related to its fundamental role in socioeconomic and environmental value, since it contributes to income generation and conservation of the Savanna biome (PAULA *et al*., 2019). Its acceptance has been gaining space on the shelves for presenting good digestibility, nutritional value, aroma and unique flavors (MAIA *et al*., 2018). In 2010, the federal government recognized the importance of the species for the income of rural populations and included it in the minimum price policy for rural products, which guarantees the production of rural communities seeking a defined minimum price. Nevertheless, currently, the commercial volume of mangaba fruit doesn't meet market demand (LIMA *et al*., 2013). Mangabeira is a species in the process of domestication that suffers the risk of extinction due to the accelerated devastation of its native areas on the northeast coast of Brazil, including the Savanna-Restinga (DA SILVA *et al*., 2017).

Deforestation of its naturally occurring areas leads to genetic erosion and the unsustainable use of the remaining individuals ends up resulting in irreparable environmental damage (SANTOS *et al*., 2017). In this sense, this research aimed to determine the chemical and antioxidant properties of mangaba fruits from naturally occurring areas in the Savanna-Restinga region in the State of Maranhão.

MATERIAL AND METHODS

Study material: Ripe fruits of five matrices of mangabeira were analyzed using letters A to E, from areas of natural occurrence in the village of Patizal (03º00'25.4"S and 43º54'22.9"W) belonging to the Rio Pirangi Settlement Project , located in the municipality of Morros, which is part of the North of Maranhãomesoregion, Rosáriomicroregion and the Munim River basin, in the State of Maranhão. The climate is classified as sub-humid, with average annual temperatures ranging from 25 to 27 ° C, relative humidity from 78 to 82% and rainfall between 1900-2300 mm year-1. The soil is classified as quartz and the vegetation is categorized as the Savanna - Sandbanks transition zone (NUGEO, 2015). The material was collected and transported in thermal boxes for analysis in the Laboratories of the Chemistry Department of the IFMA, Campus São Luís Monte Castelo. The material was cleaned, removed to impurities, crushed in an industrial blender, lyophilized (Lyophilizer model Liotop L101) and stored under vacuum in the refrigerator at 20ºC negative.

Morphometric determinations: In fruits, length (CF) and diameter (LF) were determined using a digital caliper with measurements of 50 fruits with 03 repetitions.

Physical and chemical characterization of fruits: Lipids, mineral residues, fibers and proteins, expressed in percentage, were calculated according to the methodology described by AOAC (2005). The carbohydrate content was calculated by subtracting the sum of moisture, lipids, protein, fibers and mineral waste from 1000 (BRASIL, 2008). The starch content was determined by the Lane-Eynon method (CARVALHO *et al*., 2002) The main minerals were extracted with nitric acid / perchloric acid (2:1 v/v) according to AOAC (2005) and quantified using inductively coupled plasma optical emission spectrometer (Brand Varian 720-ES).

Determination of bioactive compounds and antioxidant potential in fruits: The extracts was obtained based on the methodology described in the work of Rocha *et al*., (2013) with the preparation of the ethereal, alcoholic and aqueous extract. The total phenolic compounds were quantified using the spectrophotometric method (UV-VIS spectrophotometer (SP22-Biospectro) using the Folin-Denis reagent. The absorbance readings in a spectrophotometer, at 720nm, protected from light. of total phenolic compounds, the equation of the standard curve line constructed with gallic acid at concentrations of 0;10;15;20 and 35 mg/L was used. A spectrophotometer at different wavelengths was used to determine the content of flavonoids and anthocyanins. For anthocyanins the determination of absorbance in the spectrophotometer was at 535nm length. The anthocyanins content was calculated by multiplying the Absorbance x dilution factor/98,2. For flavonoid analysis the same procedure was performed, applying the same formula (absorbance x dilution factor/98,2) for calculation and the absorbance readings were performed at 374nm. For the determination of ascorbic acid, the methodology used was that of Lutz (2008) by the Tillmans Method, which is based on the reduction of 2,6-diclophenol indophenol-sodium (DCFI). The methodology used to determine the antioxidant property was that described in Roesler *et al*., (2007) through the method of radical reduction [2,2 - diphenyl-1-pricrylhydrazyl (DPPH)]. From aqueous and ethanolic extracts, ethanolic solutions with different concentrations were prepared. The absorbance of the sample was monitored at 517 nm. The ability to sequester free radicals was expressed as a percentage of oxidation inhibition of the radical and calculated according to the formula below:

$$\% \text{ Inhibition} = ((ADPPH - AExtr) / ADPPH) * 100$$

ADPPH = the absorbance of the DPPH solution

AExtr = the absorbance of the sample in solution

RESULTS

The mangaba fruits evaluated showed a length ranging from 3.16 to 4.25 cm, diameter ranging from 2.87 to 3.58 cm, and the CF / LF ratio close to 1 cm (Table 1). These values show that the fruits have a rounded shape, characteristic of the mangaba fruit. The nutritional composition of the analyzed samples showed the rich composition of the mangaba fruits, mainly of protein, vitamin C, ashes, fibers and minerals. In addition to the sweet taste of the fruit characterized by the high content of ºBrix. (Table 2).

Table 1. Morphometry of mangaba (*Hancorniaspeciosa* Gomes) fruits native to the Savanna-Restinga region in Maranhão

Matrices	Fruit Length (CF) Cm	Fruit diameter (LF) cm	CF / LF ratio (cm)
A	3,16	2,89	1,09
B	3,65	2,87	1,27
C	4,01	3,58	1,12
D	3,45	3,1	1,11
E	4,25	3,18	1,34
Average	3,7	3,0	1,18

Table 2. Chemical composition of mangaba fruit (*Hancorniaspeciosa* Gomes) from the Savanna-Restinga region in Maranhão

Component	Composition (%)
Protein	4,39±3,32
Lipids	19,88±1,29
Ashes	10,05±4,22
Carbohydrates	46,89±5,76
Starch	52,06±7,57
Fiber	2,20±0,85
Vitamin C	141,9±56,16
Soluble Solids (°Brix)	13,33±0,58
pH	3,35±0,07
ATT	6,62±1,95

The mineral contents were also high for sodium, calcium and potassium (Table 3). However, these data depend on the bioavailability of nutrients. Regarding bioactive compounds, the results showed high levels of phenolic compounds in alcoholic extracts and ascorbic acid in all samples analyzed. The anthocyanin contents varied from 1.5 to 4.06 mg.100g-1 and flavonoids from 1.84 to 8.75 mg.100g-1 (Table 4). The oxidative capacity to sequester free radicals from the analyzed mangaba fruits showed high levels for the ether extract in relation to the aqueous extract (Table 5).

Table 3. Minerals present in mangaba (Hancorniaspeciosa Gomes) fruits native to the Savanna-Restingaa region in Maranhão

	Minerals (mg.g^{-1})							
Matrices	Na	Ca	P	Fe	K	Mg	Mo	Mn
A	1,32±1,4	0,27±0,00	0,35±0,17	0,011±0,00	2,93±0,57	0,38±0,09	0,001±0,00	0,01±0,00
B	0,58±0,04	0,29±0,02	0,44±0,1	0,01±0,00	2,76±0,33	0,35±0,04	0,004±0,00	0,01±0,00
C	0,7±0,07	0,32±0,04	0,27±0,06	0,02±0,00	2,73±0,02	0,34±0,00	0,004±0,00	0,01±0,00
D	0,62±0,12	0,33±0,04	0,31±0,12	0,015±0,00	3,00±0,11	0,36±0,01	0,005±0,00	0,012±0,00
E	0,61±0,00	0,25±0,01	0,30±0,12	0,01±0,00	2,56±0,1	0,35±0,01	0,002±0,00	0,01±0,00
Average	0,766	0,292	0,334	0,0132	2,796	0,356	0,0032	0,0104

Table 4. Average levels of phenolic compounds in aqueous and alcoholic solution, anthocyanins, flavonoids and antioxidant in aqueous and alcoholic extract for mangaba (*Hancorniaspeciosa* Gomes) fruits native to the Savanna-Restinga region in Maranhão

Matrices	Phenoliccompounds (mg/100g)		Anthocyanins (mg/100g)	Flavonoids (mg/100g)	Ascorbicacid (mg/100g)
	Alcoholic	Aqueous			
A	53,27 ± 0,008	14,76 ± 0,005	1,5 ± 0,2	2,6 ± 0,2	286,74 ± 0,01
B	40,8 ± 0,002	8,3 ± 0,003	2,07 ± 0,15	1,84 ± 0,4	261,7 ± 0,04
C	46,73 ± 0,003	26,7 ± 0,007	4,06 ±0,2	8,75 ± 1,4	157,34 ± 0,05
D	56,37 ± 0,002	12,1 ± 0,002	1,72 ± 0,4	3,59 ± 0,3	117,32 ± 0,2
E	57,37 ± 0,002	13,63 ± 0,001	2,17 ± 0,2	3,44 ± 0,2	102,65 ± 0,2
Average	50,3175	15,098	2,304	4,044	185,15

Table 5. Antioxidant activity in aqueous and ethereal solution for mangaba (Hancorniaspeciosa Gomes) fruits native to the Savanna-Restinga region in Maranhão

Matrices	Antioxidantactivity (Aqueous) (% SRL)	Antioxidantactivity (ethereal) (% SRL)
A	39,74 ±0,03	91,7 ± 0,002
B	20,41 ± 0,16	89,88 ± 0,005
C	60,07 ±0,06	82,04 ± 0,002
D	31,08 ± 0,025	91,61 ± 0,004
E	34,73 ±0,01	84,04 ± 0,002
Average	37,2	87,85

These results indicate that the mangaba fruit has the ability to eliminate free radicals and suggest that this activity can be attributed to the phenolic compounds present in the fruit (ASSUMPCAO *et al*., 2014).

DISCUSSION

The mangaba fruits evaluated showed greater length and diameter in the morphometric characterization than other mangaba matrices in the region of Sergipe and Cerrado (DE OLIVEIRA *et al*., 2018) (Table 1). When compared to other matrices in the researched region, the values were similar (DA SILVA *et al*., 2017). The variation in the format fruit and nutritional composition consists of being a native population, without any process of selection and genetic differentiation between individuals, with high heterogeneity (DA SILVA *et al*., 2017; DA SILVA *et al*., 2017). The nutritional composition of the analyzed samples showed a rich composition of the mangaba fruits, mainly of protein, vitamin C, ashes, fibers and minerals, the sweet taste of the fruit characterized by the high ºBrix content, high acidity with the pH and ATT (Table 2). Studies with mangaba fruits have already expressed variations in the contents, mainly protein, vitamin C, starch and ashes (SOUZA *et al*., 2007). According to ASSUMPCAO *et al*., (2014) the differences are related to the application of different methods or the location of the plant's growth. The mangaba has a high content of ascorbic acid as shown in this work, so it is considered one of the richest fruits in vitamin C (VIEIRA *et al*, 2017). The high Vitamin C content in mangaba is an important quality attribute to be considered in the conservation and improvement in germplasm programs (MUNIZ *et al*., 2019). The ATT and pH values showed high acidity of the mangaba fruits, according to Nascimento *et al*., (2014) several studies showed the pH of the mangaba below 4.5. The high ºBrix content shows the sweetness of the fruit and the degree of ripeness. Values below 9 ºBrix characterize green fruits (PERFEITO *et al*., 2015). These parameters are related to the fruit's flavor and may vary according to the characteristics of the soil, climatic conditions and genetic material. The content of soluble solids is related to the amount of water available at the time of fruit ripening, so the reduction in soluble solids may occur due to excess water, while the high sugar concentration is favored by the hydric deficit (PINHEIRO *et al*., 2018). The fiber values found reveal the importance of fruit in food. For Bailao *et al*., (2015) the high fiber content is important for human health as it contributes to improving the glycemic index of the diet and weight control. Silva *et al*., (2008) already showed that mangaba in relation to other fruits of the savanna had high levels of calcium, phosphorus and iron, however they revealed that this fact doesn't affirm that the species has high nutritional value, since the bioavailability of nutrients is essential in determining the nutritional value of the food. In this way, the mangaba analyzed showed high levels of different nutritional parameters. These high values may be indicative that the pulp of these fruits is conducive to the industrialization of products such as ice cream, popsicles and jelly (NASCIMENTO *et al*., 2014). The levels of phenolic, anthocyanin and flavonoid compounds in the samples of the mangaba fruits analyzed showed high levels (Table 4) following several studies with the plant in the savanna environment (SANTOS *et al*., 2017), in addition, showed its importance as source of bioactive, which refers to its use as a medicinal plant and in the feeding of traditional communities (REIS and SCHMIEL, 2019). Savanna plants have a high content of phenolic compounds that according to (BAILAO *et al*., 2015) are justified by their exposure to water stress, high ultraviolet radiation, herbivore attacks and fungal infections. Santos *et al*., (2017) describe that in addition to phenolic compounds, anthocyanins and flavonoids may have their quantity altered according to the geographical and environmental conditions of the region, as well as being influenced by the physiological and genetic factors of the plant. The high levels of phenolic, anthocyanin and flavonoid compounds in mangaba fruit samples had repercussions on the results of the antioxidant potential in which, according to the extracts, the content of the potential to sequester free radicals suffered variations (Table 5), revealing that the mangaba is one of the main native plants of the Savanna with antioxidant potential. These contents of bioactive compounds, such as phenolic compounds, are responsible for the antioxidant activity of mangaba, which shows its potential for therapeutic activity, anti-inflammatory and antimicrobial actions and its importance for prospecting products (BAILAO *et al*., 2015). Works with the mangaba pulp extract showed a protective effect, suggesting its potential as a functional food (MAIA *et al*., 2018). Variations in the content of bioactive compounds may be related to the extraction method and the conditions of the fruits. The increase in antioxidant capacity is related to food preservation methods, as the drying process of the fruit via lyophilization changes the composition of the final products, as they change the concentration of compounds due to the loss of water in the product (PAULA *et al*., 2019). The DPPH method can also interfere with the results according to ASSUMPCAO *et al*., (2014) who compared several of the methods for determining the antioxidant activity, in which the DPPH method showed less performance when compared to the others. Bailao *et al*., (2015) highlight that the high antioxidant content of mangaba fruits may reduce the risk of developing several chronic-degenerative diseases, such as cancer and cardiovascular diseases. In addition to performing antimicrobial activity, this property has aroused great scientific interest, noting that 60% of antimicrobial drugs discovered in recent decades are of natural origin and the number of pathogens resistant to commercial antimicrobials is increasing (SANTOS *et al*., 2016).

Conclusion

The physical and chemical characterization of the mangaba fruits of the region Savanna-Restinga in Maranhão showed their nutritional wealth with high levels of protein, ashes, fibers and minerals, from some macronutrients, with emphasis on vitamin C, which makes mangaba one of the main natural sources of this vitamin among Savanna plants. In relation to bioactive compounds, the mangaba fruits showed high levels for phenolic compounds and for the ability to sequester free radicals. The results for both chemical composition and bioactivity revealed its potential as a source of nutrients in food and for its medicinal use, confirming the uses and knowledge of traditional communities.

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REFERENCES

Assumpcao, C.F., Bachiega, P., Morzelle, M.C., Nelson, D.L., Ndiaye, E.A., Rios, A.D., de Souza, E.C. 2014. Characterization, antioxidant potential and cytotoxic study of mangaba fruits. *Ciencia Rural* 44, pp.1297-1303.

Association of Oficial Analytical Chemists (AOAC), Official methods of analysis (*16th edn*). 2005. AOAC International, Washington, DC.

Bailao, E., Devilla, I.A., da Conceicao, E.C., Borges, L.L. 2015. Bioactive Compounds Found in Brazilian Cerrado Fruits. *International Journal of Molecular Sciences* 16, pp.23760-23783.

Brasil. Anvisa. RDC nº 360, de 23 dezembro de 2003.

Barbosa, A.M., Santos, K.S., Borges, G.R., Muniz, A., Mendonca, F.M.R., Pinheiro, M.S., Franceschi, E., Dariva, C., Padilha, F.F. 2019. Separation of antibacterial biocompounds from *Hancornia speciosa* leaves by a sequential process of pressurized liquid extraction. *Separation and Purification Technology* 222, pp.390-395.

Carvalho H.H, Jong E.V, Belló R.M, Souza R.B DE, Terra M.F. 2002. Alimentos: métodos físicos e químicos de analises, UFRGS, Porto alegre, p.180.

da Silva, A.V.C., Amorim, J.A.E., da Vitoria, M.F., Ledo, A.D., Rabbani, A.R.C. 2017. Characterization of trees, fruits and genetic diversity in natural populations of mangaba. *Ciencia E Agrotecnologia* 41,pp.255-262.

Da Silva, L.D.V., Araujo, J.R.G., Rocha, A.E., Carvalho, M.J.N., Braun, H., Mesquita, M.L.R. 2017. Characterization of mangabeira trees and fruits in the Savannah-Restinga Transition Zone. *Revista Brasileira De Fruticultura* 39.

de Carvalho, J.T.D., Baldivia, D.D., Leite, D.F., de Araujo, L.C.A., Espindola, P.P.D., Antunes, K.A., Rocha, P.S., Souza, K.D., dos Santose, E.L. 2019. Medicinal Plants from Brazilian Cerrado: Antioxidant and Anticancer Potential and Protection against Chemotherapy Toxicity. *Oxidative Medicine and Cellular Longevity*.

de Oliveira, R.J., da Silva, J.E.C., das Chagas, D.B. 2018. Morphology of fruits and seeds and germinate and initial development analysis of *Hancornia speciosa*. Cerne 24, pp.269-279.

Lima, I.L.P., Scariot, A., Giroldo, A.B. 2013. Sustainable Harvest of Mangaba (Hancornia speciosa) Fruits in Northern Minas Gerais, Brazil. *Economic Botany* 67, pp.234-243.

Maia, J.D., de Avila, C.R., Mezzomo, N., Lanza, M. 2018. Evaluation of bioactive extracts of mangaba (*Hancornia speciosa*) using low and high pressure processes. *Journal of Supercritical Fluids* 135, pp.198-210.

Muniz, A., da Vitoria, M.F., Nascimento, A.L.S., Ledo, A.D., Macedo, L.F.M., Muniz, E.N., Silva, J.F. 2019. Morphological and physicochemical descriptors for characterization of mangaba tree germplasm. *Revista Brasileira De Ciencias Agrarias-Agraria* 14.

Nascimento, R. S. M.; Cardoso, J. A. ; Cocozza, F. D. M. 2014. Caracterização física e físico-química de frutos de mangabeira (*Hancornia speciosa* Gomes) no oeste da Bahia. *R. Bras. Eng. Agríc. Ambiental,* 18, pp.856–860.

NUGEO - Núcleo Geoambiental. 2015. Atlas do Maranhão. São Luís: Laboratório de Geoprocessamento / GEPLAN-UEMA, p.42.

Paula, L.C., Silva, F.A., Silva, E.P., Asquieri, E.R., Damiani, C. 2019. Influence of preservation methods on the bioactivity of mangaba (*Hancornia speciosa* Gomes) from the Brazilian savannah. *Food Science and Technology* 39, pp.403-409.

Perfeito, D. G. A.; Carvalho, N. Lopes, M. C. M.; Schmidt, F. L. 2015. Caracterização de frutos de mangabas

(*Hancornia speciosa* Gomes) e estudo de processos de extração da polpa. *Revista de Agricultura Neotropical,* 2,pp. 1–7.

Pinheiro, E.A., Coimbra, R.R., Silva, K.L.F., Ferreira, W.D. 2018. Characterization and phenotypic variability in natural populations of mangabeira in the State of Ttocantins, Brazil. *Revista Caatinga* 31, pp. 560-571.

Reis, A.F., Schmiele, M. 2019. Características e potencialidades dos frutos do Cerrado na indústria de alimentos. Braz. J. Food Technol., Campinas, 22, pp.1-12.

Santos, P.S., Freitas, L.D., Santana, J.G.S., Muniz, E.N., Rabbani, A.R.C., da Silva, A.V.C. 2017. Genetic diversity and the quality of Mangabeira tree fruits (*Hancornia speciosa* Gomes - Apocynaceae), a native species from Brazil. *Scientia Horticulturae* 226, pp.372-378.

Santos, U.P., Campos, J.F., Torquato, H.F.V., Paredes-Gamero, E.J., Carollo, C.A., Estevinho, L.M., Souza, K.D., dos Santos, E.L. 2016. Antioxidant, Antimicrobial and Cytotoxic Properties as Well as the Phenolic Content of the Extract from *Hancornia speciosa* Gomes. Plos One 11.

Santos, E. F. de; Araújo, R. R. de.; Lemos, E. E. P. de.; Endres, L. 2017. Quantificação de compostos bioativos em frutos de mangaba (*Hancornia specios*a Gomes) nativos de Alagoas, Ciência Agrícola, 15, pp.17-22.

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

Souza, F. G de; Figueiredo, R. W de.; Alves, R. E.; Maia, G. A.; Araújo, I. A. de. 2007. Qualidade pós-colheita de frutos de diferentes clones de mangabeira (*Hancornia speciosa* Gomes). Ciência e Agrotecnologia, 31, pp.1449-1454.

Rocha, M. S.; Figueiredo, R. W.;Araujo, M. A da M.; Moureira A, R. S. dos. 2013. Caracterização físico-química e atividade antioxidante (in vitro) de frutos do cerrado piauiense. Revista Brasileira de Fruticultura, 35,pp.933-941.

Roester, R.; Malta, L. G.; Carrasco, L.C.; Holanda, R. B.; Sousa, C. A. S; Pastore, G. M. 2007. Atividade antioxidante de frutos do cerrado. Ciência Tecnologia de Alimentos, 27, pp.53-60.

Vieira, M. C.; Souza, E. R. B. ; Paula, M. S. P; Naves, R. V.; Silva, G. D. 2017. Mangabeira (*Hancorniaspeciosa* Gomes): uma frutífera promissora do Brasil. Scientific Electronic Archives Issue ID: Sci. Elec. Arch. 10, pp.45-55.

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