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Scientific Article

Physicochemical quality and bioactive compounds in orange-fleshed sweet potato

Qualidade físico-química e compostos bioativos em batata-doce de polpa alaranjada

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ABSTRACT - Sweet potato is a vital food root, rich in vitamins, minerals, and bioactive compounds. Genotypes that meet these nutritional demands are essential to combat nutrient deficiencies and promote human health. Thus, it presupposes the hypothesis that sweet potato genotypes differ in physicochemical quality and bioactive compounds when evaluated under the same environmental conditions. Thus, this study aims to evaluate the physicochemical quality and bioactive compounds in genotypes of orange-fleshed sweet potato. The experiment was conducted from April 2022 to August 2022 in the experimental area of Agronomic Engineering, located at the Academic Unit Specialized in Agricultural Sciences (UAECA) - UFRN, in Macaíba, RN, Brazil. The treatments were composed of eight genotypes, being two cultivars (BRS Amélia and Beauregard) and six accessions (Macaíba I, Macaíba II, Macaíba III, Macaíba IV, Ceará-Mirim, and Natal I) of orange-fleshed sweet potato from the UAECA teaching collection. After harvest, the following characteristics were evaluated: firmness, elasticity, hydrogen potential (pH), titratable acidity (TA), soluble solids (SS), ratio (SS/TA), Vitamin C, and the bioactive compounds: anthocyanins, flavonoids, and total carotenoids. The orange-fleshed sweet potato genotypes showed distinct characteristics for the physicochemical variables and the bioactive compounds. Due to increased pulp pH, anthocyanins were reduced in the Ceará-Mirim, Macaíba III, and Macaíba IV genotypes. The Macaíba II and Natal I genotypes stood out regarding the SS/TA ratio, flavonoids, and anthocyanins. In contrast, the Macaíba III genotype had the highest carotenoid content and great bioactive potential.

Keywords: *Ipomoea batatas*. Biofortification. Antioxidant. Tuberous roots.

RESUMO - A batata-doce é uma raiz alimentar vital, rica em vitaminas, minerais e compostos bioativos. Genótipos que atendam a essas demandas nutricionais são essenciais para combater deficiências de nutrientes e promover a saúde humana. Assim, pressupõe-se a hipótese de que os genótipos de batata-doce diferem na qualidade físico-química e nos compostos bioativos quando avaliados sob as mesmas condições ambientais. Deste modo, este estudo tem como objetivo avaliar a qualidade físico-química e os compostos bioativos em genótipos de batata-doce de polpa alaranjada. O experimento foi conduzido de abril de 2022 a agosto de 2022, na área experimental de Engenharia Agronômica, localizada na Unidade Acadêmica Especializada em Ciências Agrárias (UAECA) - UFRN, em Macaíba, RN, Brasil. Os tratamentos foram compostos por oito genótipos, sendo duas cultivares (BRS Amélia e Beauregard) e seis acessos (Macaíba I, Macaíba II, Macaíba III, Macaíba IV, Ceará-Mirim e Natal I) de batata-doce de polpa alaranjada da coleção didática da UAECA. Após a colheita, foram avaliadas as seguintes características: firmeza, elasticidade, potencial hidrogeniônico (pH), acidez titulável (AT), sólidos solúveis (SS), razão (SS/AT), vitamina C e os compostos bioativos: antocianinas, flavonoides e carotenoides totais. Os genótipos de batata-doce de polpa alaranjada apresentaram características distintas para as variáveis físico-químicas e os compostos bioativos. Devido ao aumento do pH da polpa, as antocianinas foram reduzidas nos genótipos Ceará-Mirim, Macaíba III e Macaíba IV. Os genótipos Macaíba II e Natal I se destacaram quanto à relação SS/AT, flavonoides e antocianinas. Em contrapartida, o genótipo Macaíba III apresentou o maior teor de carotenoides e grande potencial bioativo.

Palavras-chave: *Ipomoea batatas*. Biofortificação. Antioxidante. Raízes tuberosas.

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INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam] is a tuberous root of worldwide importance, belonging to a group of foods that are part of the commodity of roots and tubers (CARTABIANO-LEITE; PORCU; CASAS, 2020). This crop has greater diversity in the color of the pulp, which can be light yellow, orange and purple and, depending on the color, the amount of phytochemicals is differentiated, with orange ones being rich in carotenoids and purple ones being rich in anthocyanins (ISLAM et al., 2016; CHEN et al., 2019). Orange-fleshed sweet potatoes are rich in beta-carotene and provitamin A (ZEIST et al., 2022). Therefore, it is interesting to select sweet potato genotypes with orange flesh (LEAL et al., 2021), which are most often biofortified (BENTO, 2021).

Thus, the development of biofortified foods aims to mitigate nutritional deficiencies by increasing the amounts and bioaccessibility of nutrients in crops to select new varieties (OFORI et al., 2022). In this context, sweet potato has stood out due to the pursuit of a healthier lifestyle, facilitated by its easy availability compared to other foods with similar nutritional value, as it is rich in nutrients that benefit human health, such as anthocyanins, phenolic compounds, dietary fiber, ascorbic acid, folic acid, and mineral salts (ELLONG; BILLARD; ADENET, 2014). It is essential to highlight that variations in pulp color are associated with variations in these compounds (PARK et al., 2015).

These compounds are altered by various factors, such as inefficient harvesting practices, temperature and humidity fluctuations, as well as the incidence of pests and diseases, which favor post-harvest losses. Furthermore, the use of genotypes plays an essential role in reducing post-harvest losses by enhancing resistance against pests, diseases, and adverse environmental conditions, thereby extending the shelf life of tuber crops (RAJU, 2021). It is worth noting that, after harvesting, metabolic and biochemical changes occur in the tubers, affecting composition, texture, and quality of the final product (REN et al., 2021).

Considering the vast genetic diversity of sweet potatoes and the variability in the responses of individuals of the same species, it is necessary to research to evaluate not only the production but also the quality of different genotypes, which may show different responses even when cultivated in the same environment (VARGAS et al., 2018; FROND et al., 2019). Thus, it presupposes the hypothesis that sweet potato genotypes differ in physicochemical quality and bioactive compounds when evaluated under the same environmental conditions. Thus, this study aims to evaluate the physicochemical quality and bioactive compounds in orange-fleshed sweet potato.

MATERIAL AND METHODS

The experiment was carried out from April 2022 to August 2022 in the Experimental Area of Agronomic Engineering, located at the Academic Unit Specialized in Agricultural Sciences (UAECA), campus of the Federal University of Rio Grande do Norte (UFRN), in Macaíba, RN, Brazil, located at the following coordinates: 5°53'40.38"S latitude, 35°21'47.94"W longitude and 52 m altitude. The region's climate is characterized as As, according to Köppen's classification, with a rainy season between May and July and a dry season between September and December (ALVARES et al., 2013). Meteorological data were collected at the automatic meteorological station of Macaíba, RN (Figure 1). The soil of the study area is classified as *Argissolo Amarelo* (Ultisol) (SANTOS et al., 2018).

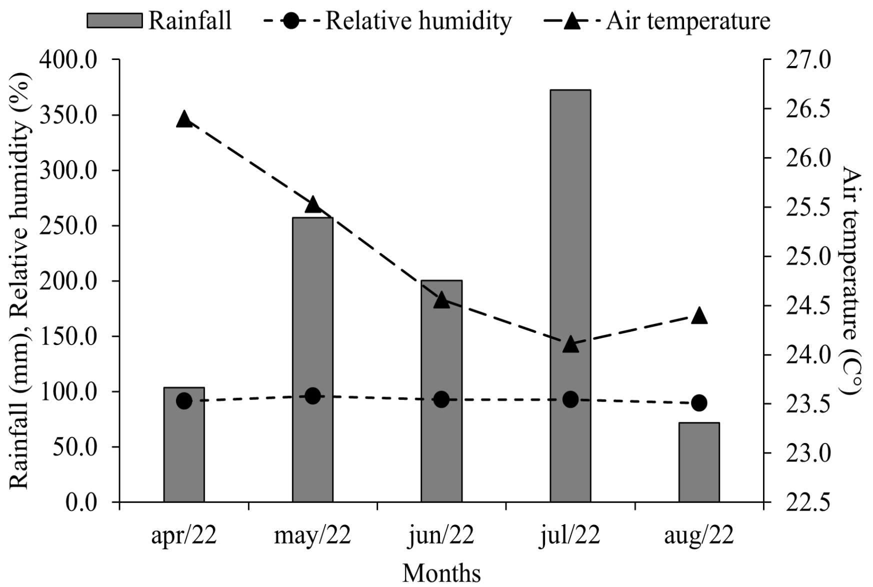

Figure 1. Meteorological data collected during the experimental period. Source: Instituto Nacional de Meteorologia - INMET (2022).

In the experimental area, soil samples were collected at a depth of 0 to 0.20 m to check the physical and chemical properties of the soil before the experiments were set up (Table 1). The area was prepared with heavy harrowing, followed by leveling harrowing to homogenize the surface. The rows were made with a furrower, each row being 30 meters long and spaced 1 meter apart. Fertilization was carried out by applying 5 liters of well-decomposed bovine manure per linear meter. Irrigation was applied by a drip system.

Table 1. Physical-chemical analysis of the soil in the experimental area.

Depth	pH	P	K^+	Na^+	Ca^{2+}	Mg^{2+}	Sand	Silt	Clay
m		------------- mg dm^{-3} -------------			---------- cmol$_c$ dm^{-3} ----------		--------------- g kg^{-1} ---------------		
0 - 0.20	5.7	4	50	21	0.83	0.42	897	83	20

Eight sweet potato genotypes were used (Figure 2), being two cultivars (BRS Amélia and Beauregard) and six accessions (Macaíba I, Macaíba II, Macaíba III, Macaíba IV, Ceará-Mirim and Natal I). The genotypes were obtained from the didactic collection of the UAECA, located in Macaíba, RN, Brazil. A randomized block design was used, with 4 replications for each treatment. One sweet potato genotype with orange flesh was planted in each bed. The spacing between the holes was 0.40 m, and one branch was planted per hole. Each replication consisted of seven meters, with a spacing of 0.50 m between them, totaling 30 meters in length.

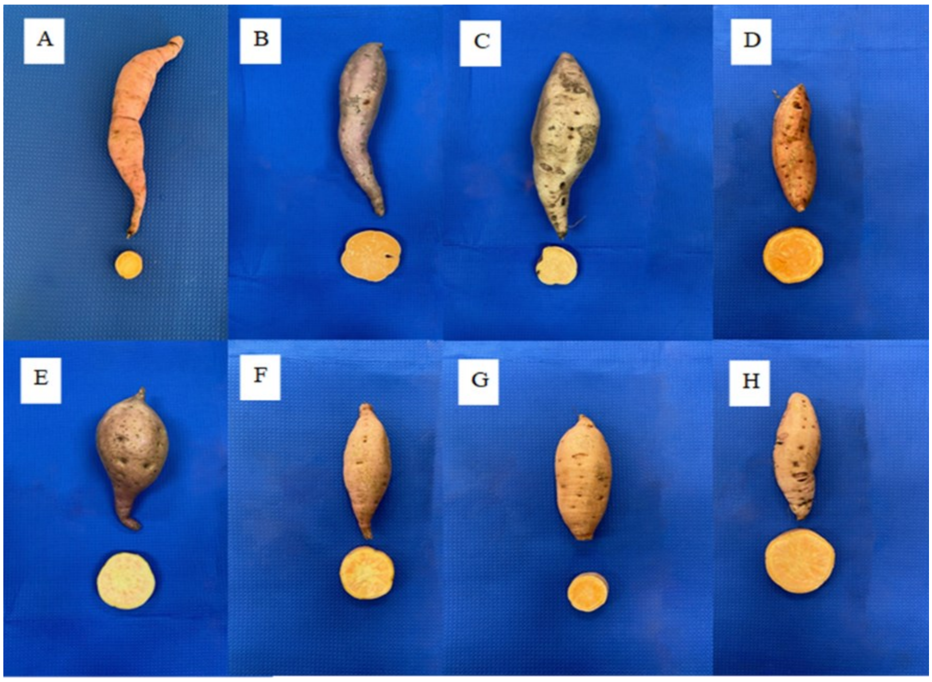

Figure 2. Roots of orange-fleshed sweet potato genotypes, BRS Amélia (A), Beauregard (B), Ceará-Mirim (C), Macaíba I (D), Macaíba II (E), Macaíba III (F), Macaíba IV (G), and Natal I (H).

At 150 days after planting, the tuberous roots were harvested and sent to the Laboratory for the Reception of Materials of the Semi-Arid Research Center (CPVSA), DCAF/CCA. Subsequently, the tuberous roots were separated, and roots with damage from cuts, pathogens, insects, and animals were discarded. The tuberous roots were evaluated for the physical descriptors: firmness and elasticity. Firmness and elasticity were determined from two tuberous roots from each replication of the genotypes using a benchtop texture analyzer (Stable Micro Systems, model TA. XT Express/TA. XT2icon). A cylindrical probe of 5 mm in diameter was used, three equidistant measurements were taken, and the mean between them was considered. Firmness was expressed in Newton (N) and elasticity in millimeters (mm).

Additionally, some of the selected tuberous roots were washed, processed, and the obtained pulp was stored in plastic containers, being kept in a freezer for later analyses. The characteristics evaluated were: hydrogen potential (pH), determined by direct reading in the equipment (Model mPA-210 Tecnal®, Brazil) and expressed in absolute pH values (AOAC, 2002); titratable acidity (TA), expressed in (%) (CANO et al, 2008); soluble solids (SS), expressed in °Brix (AOAC, 2002); ratio (SS/TA), determined by the ratio of soluble solids to titratable acidity; vitamin C, expressed as mg 100 g^{-1}, determined by titrimetry and using the Tillman solution (STROHECKER; HENNING, 1967); anthocyanins and flavonoids, expressed as mg 100 g^{-1} fresh mass, using the Ethanol-HCl (1.5 N) solution and with wavelengths of 535 and 374 nm, respectively (FRANCIS, 1982); and total carotenoids, expressed as mg 100 g^{-1} fresh mass, determined in separation funnels and at 450 nm (HIGBY, 1962).

The data obtained were subjected to the Shapiro-Wilk normality test, then subjected to analysis of variance using the F test. The means were compared using the Scott-Knott test at 5% probability level when significant. Principal component analysis (PCA), Pearson correlation, cluster analysis and principal coordinate analysis (PCoA) were performed to verify the relationship between the studied variables. The analyses were performed using the statistical analysis software XLSTAT and PAST4.

RESULTS AND DISCUSSION

There was no significant difference in the firmness variable between the sweet potato genotypes studied (Table 2). However, the genotypes showed significant differences in elasticity (Table 2). The BRS Amélia [-0.216], Macaíba III [-1.293] and Macaíba IV [1.962] genotypes had similar elasticities, but higher than those of the Beauregard [-6.100], Ceará-Mirim [-12.291], Macaíba I [-3.666], Macaíba II [-3.813] and Natal I genotypes (Table 2).

Table 2. Mean values and standard error of the mean for firmness and elasticity of orange-fleshed sweet potato genotypes.

Genotypes	Firmness (N)	Elasticity (mm)
BRS Amélia	101.203 ± 1.28	-0.216a ± 0.78
Beauregard	90.190 ± 2.45	-6.100c ± 1.17
Ceará-Mirim	96.783 ± 2.53	-12.291d ± 1.25
Macaíba I	98.496 ± 3.47	-3.666b ± 0.89
Macaíba II	101.857 ± 3.08	-3.813b ± 0.68
Macaíba III	98.068 ± 3.50	-1.293a ± 0.71
Macaíba IV	96.481 ± 1.64	1.962a ± 2.39
Natal I	95.056 ± 4.19	-6.726c ± 0.96
Mean	97.267	-4.018
P	0.170	<0.0001
CV (%)	7.36	-74.68

Means followed by the same letter in the column do not differ from each other according to the Scott-Knott test at $p < 0.05$.

The Macaíba IV genotype [1.961 mm] shows positive values after compression, unlike the other genotypes, which have negative mean values, indicating that less deformation has occurred. The samples' greater elasticity indicates that they have a greater capacity to recover compression energy, which translates into greater resilience (PATERNINA; LUNA; BERMUDEZ, 2022). The cellular content of these products is mainly composed of water, and the loss of this water can lead to sagging and wilting of the cell walls (OLIVEIRA et al., 2024a).

The orange-fleshed sweet potato genotypes showed significant differences for the pH variable; the BRS Amélia, Beauregard, Ceará-Mirim, and Macaíba IV genotypes showed similar and higher averages than the Macaíba II genotype (Figure 3A). The genotype values ranged from 5.5 (Macaíba II) to 5.9 (Ceará Mirim). These results corroborate those found by Uchôa et al. (2016), who found that in orange-fleshed sweet potatoes there was a variation in the range of 5 to 6 on the pH scale, which is considered close to ideal (5.5). These pH ranges obtained are satisfactory because the more acidic, the greater the oxidative action on the natural pigments; therefore, this action leads to loss of carotenoids, which negatively affects the quality and quantity of provitamin A in orange-fleshed sweet potatoes (UCHÔA et al., 2016).

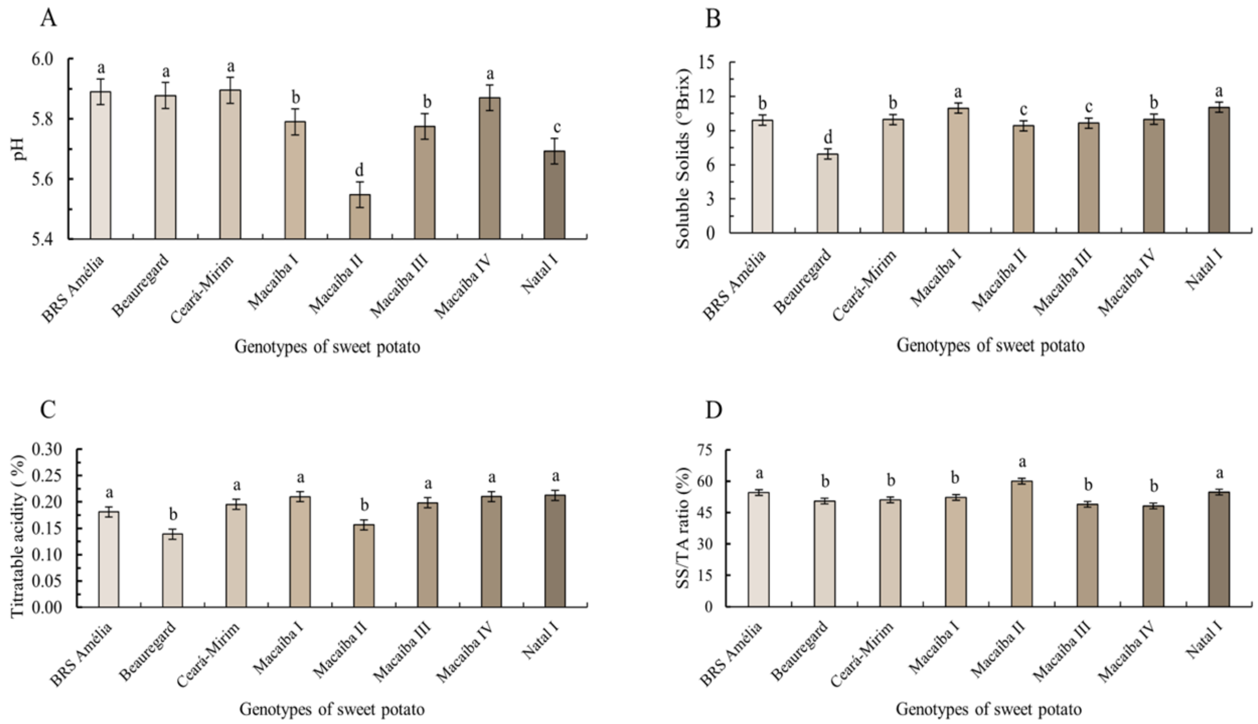

Figure 3. pH (A), Soluble solids - SS (B), Titratable acidity - TA (C), and SS/TA ratio (D) of orange-fleshed sweet potato roots.

The SS of the orange-fleshed sweet potato genotypes ranged from 6.93 to 11.02 °Brix for the Beauregard and Natal I genotypes, respectively. The Macaíba I and Natal I genotypes showed statistically similar and higher mean values than the other orange-fleshed sweet potato genotypes (Figure 3B). The Beauregard genotype had the lowest SS content compared to the other genotypes. This finding was similar to that of Pilon et al. (2021), who found that Beauregard had the lowest SS content compared to other orange-fleshed sweet potato genotypes, with values ranging from 5.12 to 10.55 ° Brix.

The TA of the genotypes ranged from 0.138% to 0.210% for Beauregard and Macaíba IV, respectively. The genotypes BRS Amélia, Ceará-Mirim, Macaíba I, Macaíba III, Macaíba IV and Natal I showed statistically similar and higher means than the Beauregard cultivar (Figure 3C). Vizzotto et al. (2017) obtained mean values between 0.12 and 0.13% with different sweet potato genotypes. The mean values were lower than those found in the present study.

The genotypes Macaíba II [60.07], Natal I [54.73], and BRS Amélia [54.62] showed similar results for the SS/TA ratio variable. However, they had higher average values compared to the genotypes Macaíba I [52.23], Ceará-Mirim [50.99], Beauregard [50.46], Macaíba III [48.88], and Macaíba IV [48.21] (Figure 3D). The evaluation of the relationship between soluble solids and titratable acidity is one of the most widely used characteristics, as it is a crucial component to determine with better precision the flavor present in fruit and vegetables, providing an adequate concept of the balance between these two variables, proving to be even more representative than the isolated measurement of sugars or titratable acidity (OLIVEIRA et al., 2024b).

There was no significant difference between the genotypes for vitamin C content (Figure 4A). However, the mean values found in the present study were higher than those found by Ellong, Billard and Adenet (2014), which ranged from 20.50±0.28 mg 100 g^{-1} to 5.30±0.00 mg 100 g^{-1}.

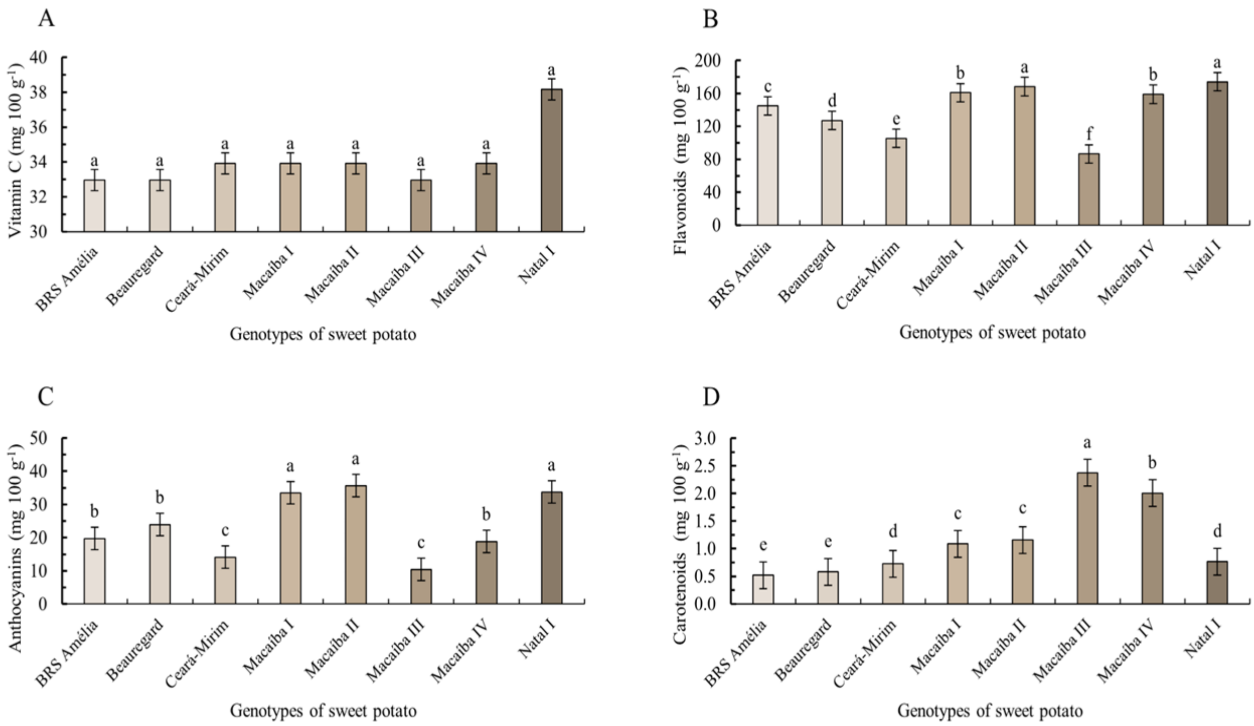

Figure 4. Vitamin C (A), Flavonoids (B), Anthocyanins (C), and Carotenoids (D) in roots of orange-fleshed sweet potato.

There was a significant difference between the genotypes for flavonoid content, with Natal I and Macaíba II showing similar and higher averages than the other genotypes. The mean flavonoid content ranged from 86.48 to 174.11 mg 100 g^{-1}, for the Macaíba III and Natal I genotypes, respectively (Figure 4B). Krochmal-Marczak et al. (2021), in a study with different sweet potato cultivars, found that the mean values ranged from 2.24±0.29 mg g^{-1} to 4.58±0.33 mg g^{-1}, which are lower than those observed in the present study.

For anthocyanin content, the values ranged from 10.43 to 35.64 mg 100 g^{-1} in the orange-fleshed sweet potatoes (Figure 4 C). Macaíba I, Macaíba II and Natal I showed higher values than the other genotypes. Bennett et al. (2021) evaluated different purple-fleshed sweet potatoes and found higher mean values ranging from 7.25 mg g^{-1} to 8.23 mg g^{-1}. Chen et al. (2019) mention that anthocyanins are unstable at high pH values. This behavior is demonstrated in the genotypes Macaíba I, Macaíba II and Natal I, which showed higher averages in anthocyanin levels compared to the other genotypes at reduced pH values.

The carotenoid content differed statistically among the orange-fleshed sweet potato genotypes (Figure 4D). The mean values of carotenoids ranged from 0.519 to 2.375 mg 100 g^{-1}, and Macaíba III showed higher levels than the other genotypes. The two cultivars analyzed, BRS Amélia [0.519] and Beauregard [0.579], obtained the lowest average values. This variation in carotenoid content may be associated with genetic differences in the material relative to the shade of the pulp, since carotenoids are fat-soluble pigments that give fruits and vegetables their yellow, orange, and red colors (BALIĆ; MOKOS, 2019). Ellong, Billard and Adenet (2014) found in their work higher mean values of carotenoids in the sweet potato genotypes, compared to the present research. Thus, the sweet potato genotypes that showed a marked orange hue in the roots have the highest values of carotenoid content.

The total variation was 71.90% with the sum of the principal components (PC) (Figure 5). PC1 contributed with 43.90% of the total variation. It showed positive correlations with the variables SS/TA ratio, anthocyanins, flavonoids, vitamin C, soluble solids and titratable acidity, where the Macaíba II genotype was close to the SS/TA ratio and anthocyanins. PC2 contributed with 28.00% of the total variation and showed negative correlations with pH. There is also an inversely proportional behavior of pH with anthocyanins and the SS/TA ratio, demonstrating the antagonism between the variables. In addition, the Beauregard genotype showed distancing from the other variables.

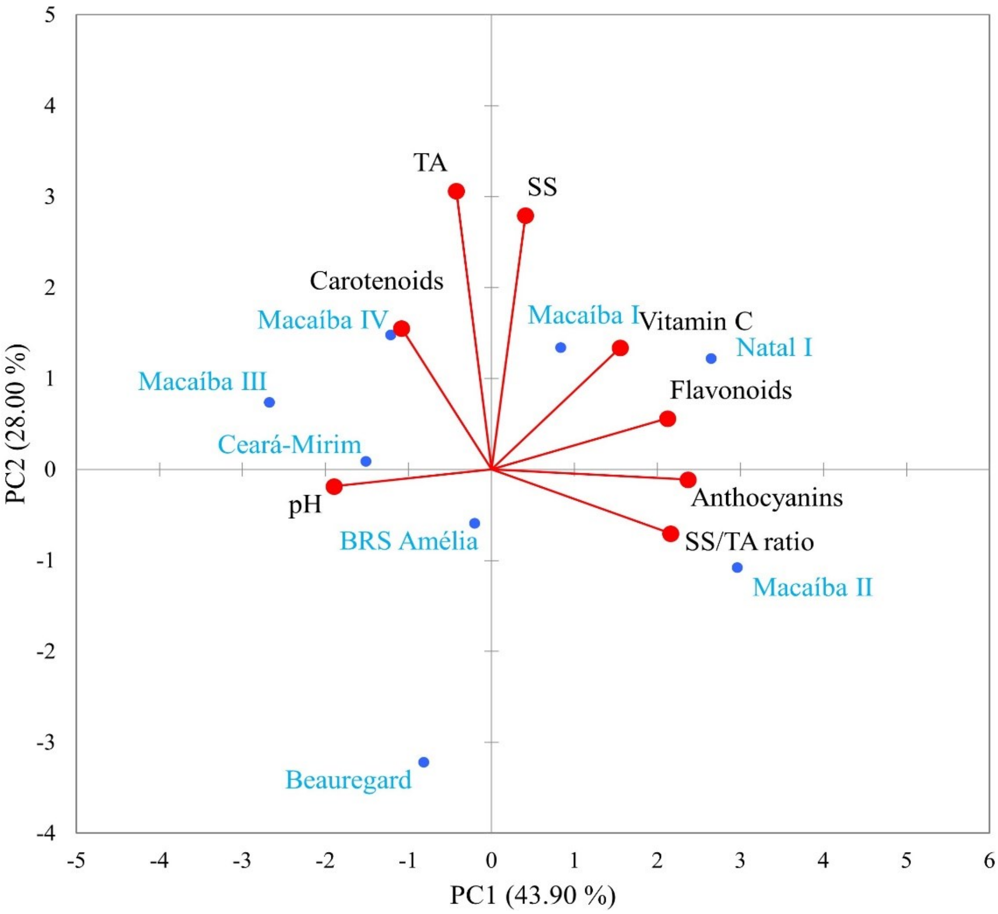

Figure 5. Principal component analysis (PCA) of physicochemical variables and bioactive compounds of sweet potato genotypes.

The pH showed negative correlations with anthocyanins (-0.67) and the SS/TA ratio (-0.75), respectively, moderate and strong. Strong positive correlations were observed for soluble solids and titratable acidity (0.86) and flavonoids and anthocyanins (0.85). Carotenoid content was negatively correlated with pH, vitamin C, and flavonoids with very weak strengths (-0.12), (-0.20), and (0.30), in the same order (Figure 6).

The genotypes studied were divided into three groups (Figure 7). Group 1 comprised the genotypes BRS Amélia, Beauregard and Macaíba IV. Group 2 is composed of the genotypes Ceará-Mirim and Macaíba III, while Group 3 is composed of the genotypes Macaíba I, Macaíba II and Natal I. The dendrogram generated showed a cophenetic correlation of 0.77, i.e., the dendrogram preserved the original distances between the samples. They were favoring more excellent data reliability. Group 2 (Ceará-Mirim and Macaíba III) had a bootstrap of 80%, indicating stability and reliability in the samples, thus providing certainty and similarity in this grouping.

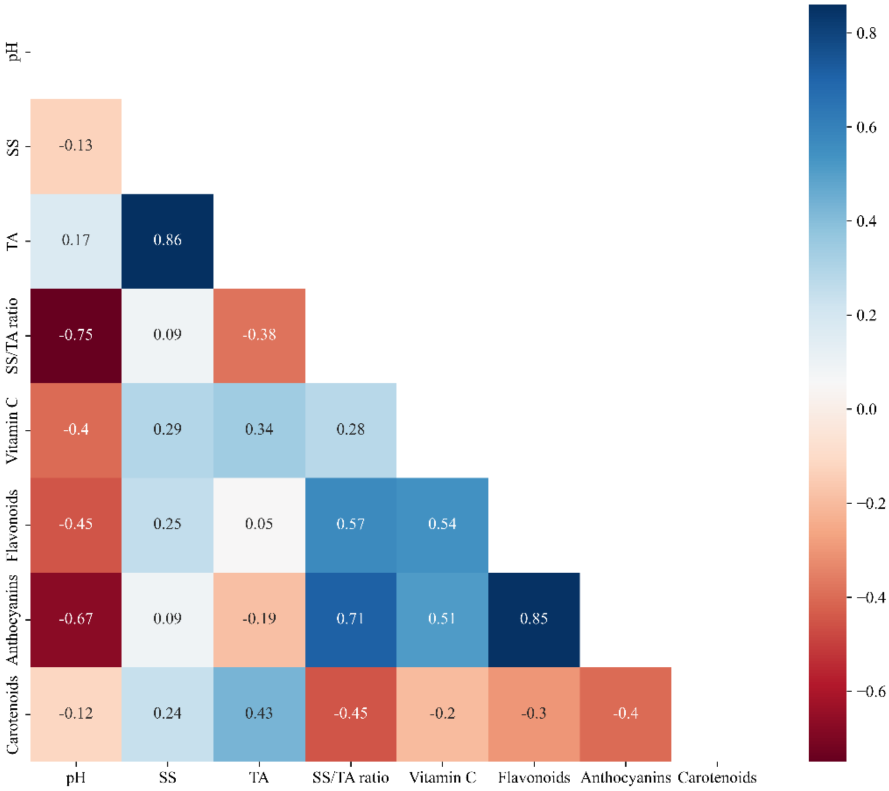

Figure 6. Pearson's correlation between physicochemical variables and bioactive compounds of sweet potato genotypes.

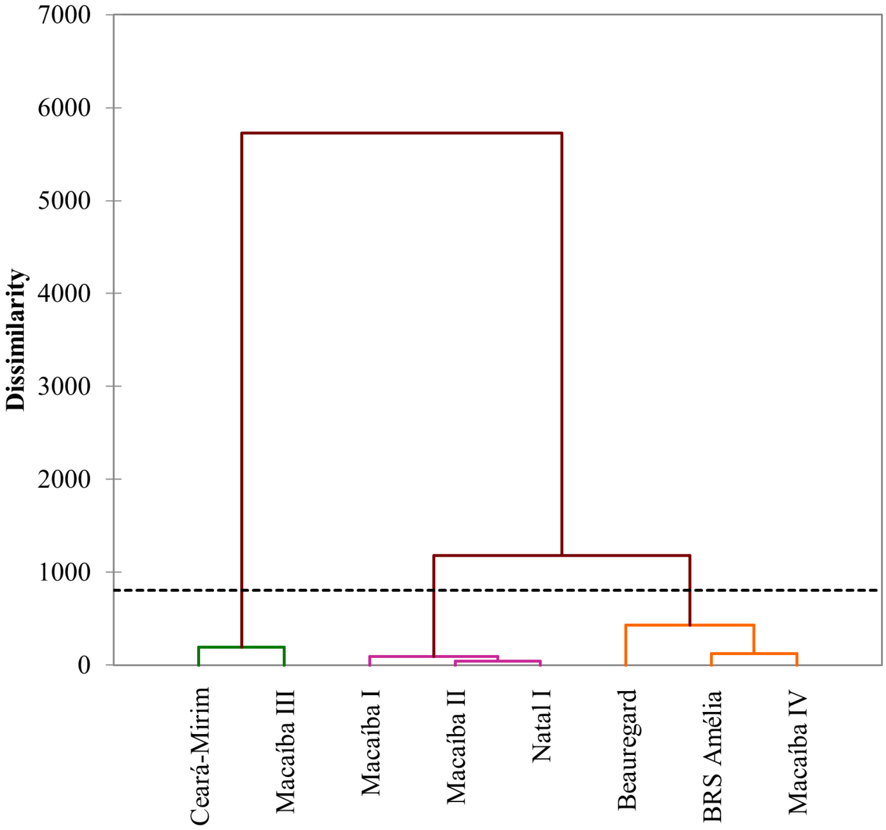

Figure 7. Cluster analysis in orange-fleshed sweet potato genotypes.

Principal coordinate analysis (PCoA) of the eight orange-fleshed sweet potato genotypes was used to show the genetic relationship between the genotypes (Figure 8). The sum of the principal coordinates shows 75.94% of the total genetic variation. The primary coordinate 1 was responsible for 61.34% of the explained variance, showing the proximity of the BRS Amélia, Macaíba and Beauregard genotypes. In comparison, the central coordinate 2 accounted for 14.60% of the explained variance, showing proximity of the Natal 1, Macaíba II and Macaíba I genotypes, which showed scores of -3.511, -3.239 and -2.642 , respectively. The Ceará-Mirim and Macaíba III genotypes were distant from the other genotypes but similar in the cluster analysis (Figure 8).

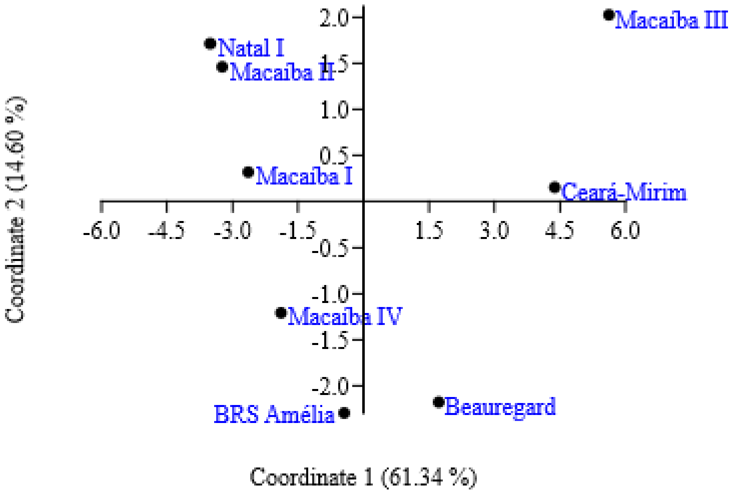

Figure 8. Principal coordinate analyses (PCoA) of orange-fleshed sweet potato genotypes.

CONCLUSIONS

The orange-fleshed sweet potato genotypes showed distinct characteristics for the physicochemical variables and the bioactive compounds.

Due to increased pulp pH, anthocyanins were reduced in the Ceará-Mirim, Macaíba III, and Macaíba IV genotypes.

The Macaíba II and Natal I genotypes stood out regarding the SS/TA ratio, flavonoids, and anthocyanins. In contrast, the Macaíba III genotype had the highest carotenoid content and great bioactive potential.

REFERENCES

ALVARES, C. A. et al. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, 22: 711-728, 2013.

AOAC - Association of Official Analytical Chemistry. **Official methods of analysis of the Association of Official Analytical Chemistry**. 17. ed. Washington: AOAC, 2002. 1115 p.

BALIĆ, A.; MOKOS, M. Do we utilize our knowledge of the skin protective effects of carotenoids enough?. **Antioxidants**, 8: 1-19, 2019.

BENNETT, A. A. et al. Untargeted metabolomics of purple and orange-fleshed sweet potatoes reveals a large structural diversity of anthocyanins and flavonoids. **Scientific Reports**, 11: 1-13, 2021.

BENTO, K. J. Use of orange fleshed sweet potato [*Ipomoea batatas* (L) Lam] to combat vitamin A deficiency. **International Journal of Plant Breeding and Crop Science**, 8: 1033-1038, 2021.

CANO, C. B. et al. Conservas vegetais, frutas e produtos de frutas. In: ZENEBON, O.; PASCUET, N. S.; TIGLEA, P. (Eds.). **Métodos físico-químicos para análise de alimentos**. 4. ed. São Paulo, SP: Instituto Adolfo Lutz, 2008. cap. 15, p. 567-587.

CARTABIANO-LEITE, C. E.; PORCU, O. M.; CASAS, A. F. Sweet potato (*Ipomoea batatas* L. Lam) nutritional potential and social relevance: a review. **History**, 11: 23-40, 2020.

CHEN, C. C. et al. Stability and Quality of Anthocyanin in Purple Sweet Potato Extracts. **Foods**, 2019, 8: 1-13, 2019.

ELLONG, E. N.; BILLARD, C.; ADENET, S. Comparison of physicochemical, organoleptic and nutritional abilities of eight sweet potato (*Ipomoea batatas*) varieties. **Food and Nutrition Sciences**, 5: 1-6, 2014.

FRANCIS, F. J. Analysis of anthocyanins. In: MARKAKIS, P. **Anthocyanins as food colors**. London, UK: Academic Press, 1982. cap. 7, p. 182-204.

FROND, A. D. et al. Phytochemical characterization of five edible purple-reddish vegetables: Anthocyanins, flavonoids, and phenolic acid derivatives. **Molecules**, 24: 1536, 2019.

HIGBY, W. K. A. A simplified method for determination of some the carotenoid distribuition in natural and carotene-fortified orange juice. **Journal of Food Science**, 27: 42-49, 1962.

INMET - Instituto Nacional de Meteorologia. **Dados meteorológicos**. 2022. Available at: https://mapas.inmet.gov.br/#. Access on: Jan. 15, 2024.

ISLAM, S. N. et al. Carotenoids and β-carotene in orange fleshed sweet potato: A possible solution to vitamin A deficiency. **Food Chemistry**, 199: 628-631, 2016.

KROCHMAL-MARCZAK, B. et al. Comparative assessment of phenolic content, cellular antioxidant, antityrosinase and protective activities on skin cells of extracts from three sweet potato (*Ipomoea batatas* (L.) Lam.) cultivars. **Journal of King Saud University-Science**, 33: 101532, 2021.

LEAL, M. H. S. et al. Selection of new sweet potato genotypes based on production parameters, physical root characteristics and resistance to *Euscepes postfasciatus*. **Journal of Crop Science and Biotechnology**, 24: 349-360, 2021.

OFORI, K. F. et al. Improving nutrition through biofortification–A systematic review. **Frontiers in Nutrition**, 9: 1-20, 2022.

OLIVEIRA, P. H. A. et al. Production and physical quality of sweet potatoes under phosphate fertilization. **Revista Caatinga**, 37: e11399, 2024a.

OLIVEIRA, P. H. A. et al. Chemical quality and bioactive compounds of sweet potatoes under phosphate fertilization. **Revista Brasileira de Engenharia Agrícola e Ambiental**, 28: e274451, 2024b.

PARK, S. C. et al. Enhanced accumulation of carotenoids in sweetpotato plants overexpressing IbOr-Ins gene in purple-fleshed sweetpotato cultivar. **Plant Physiology and Biochemistry**, 86: 82-90, 2015.

PATERNINA, G. A.; LUNA, F. V.; BERMUDEZ, A. A. Nutraceutical, thermophysical and textural characteristics of papaya (*Carica papaya* L.) and incidence for post-harvest management. **Heliyon**, 8: 1-7, 2022.

PILON, L. et al. Quality characterization, phenolic and carotenoid content of new orange, cream and yellow-fleshed sweetpotato genotypes. **Horticultura Brasileira**, 39: 299-304, 2021.

RAJU, S. Strategies for enhancing post-harvest quality and shelf life of tuber crops: Insights from physiological perspectives. **Journal of Root Crops**, 47: 40-52, 2021.

REN, L. et al. Exploring the metabolic changes in sweet potato during postharvest storage using a widely targeted metabolomics approach. **Journal of Food Processing and Preservation**, 45: e15118, 2021.

SANTOS, H. G. et al. **Sistema brasileiro de classificação de solos**. 5.ed., revisada e ampliada. Brasília, DF: Embrapa, 2018. 356 p.

STROHECKER, R.; HENNING, H. M. **Analisis de vitaminas: métodos comprobados**. Paz Montalvo: Madrid, 1967. 428 p.

UCHÔA, V. T. et al. Caracterização físico-química de batata-doce (*Ipomoea batatas*) comum e biofortificada. **Revista Ciência Agrícola**, 13: 53-60, 2016.

VARGAS, P. F. et al. Genetic diversity among sweet potato crops cultivated by traditional farmers. **Revista Caatinga**, 31: 779-790, 2018.

VIZZOTTO, M. et al. Physicochemical and antioxidant capacity analysis of colored sweet potato genotypes: in natura and thermally processed. **Ciência Rural**, 47: e20151385, 2017.

ZEIST, A. R. et al. Selecting orange-fleshed sweet potato genotypes using selection indices. **Horticultura Brasileira**, 40: 231-237, 2022.