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Research note

Physicochemical variability in Brazilian guava accessions grafted onto a nematode resistant rootstock

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Abstract

Guava is a fruit species of worldwide importance due to its characteristics favorable for consumption; for example, aroma, flavor, texture and vitamin C. This study aimed to characterize the physicochemical variability of Brazilian guava accessions grafted onto BRS Guaraçá, a nematode resistant rootstock, to guide the development of new cultivars. Fruits from 87 accessions from the Embrapa Semiárido *Psidium* Germplasm Bank, sampled in 12 Brazilian States and established at Petrolina, PE, Brazil, were analyzed in 2020 for peel and pulp color, pulp firmness, titratable acidity, soluble solids, vitamin C, lycopene, and β-carotene in the fresh pulp. The data were subjected to analysis of variance and histograms construction. The results were significant ($p<$ 0.05) for all quantitative variables, indicating phenotypical variability among accessions. The β-carotene contents ranged from 0.02 to 1.83 mg.100 g^{-1}, with a mean of 0.49 mg 100 g^{-1}. The lycopene mean value was 0.77 mg100 g^{-1}, ranging from 0 to 3.7 mg 100 g^{-1}. Accessions GUA33PE and GUA135RR showed high pulp firmness values and are recommended for the development of cultivars with greater resistance to transport. Accessions GUA31PI, with 686 mg 100 g^{-1} and GUA48SE, with 621 mg 100 g^{-1}, showed high values of vitamin C and are recommended for the development of cultivars with higher contents of this bioactive compound.

Palabras clave:

Psidium guajava, BRS Guaraçá, bioactive compounds, vitamin C.

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The guava fruits are highly appreciated by consumers, fresh or processed, due to its characteristic flavor and high vitamin C content (Corrêa *et al.*, 2011). Brazil is a major world producer, with a production of 564.764 t in 22.63 ha (IBGE, 2023). Studies on germplasm characterization and genetic diversity generate essential information for the development of new cultivars (Coser *et al.*, 2014). According to Corrêa *et al.* (2011), the evaluation of traits related to sweetness and acidity, as well as the content of bioactive compounds are essential for the development of guava cultivars.

Ascorbic acid, a main guava bioactive compound, is a water-soluble vitamin of great nutrient importance since human beings do not synthesize this vitamin (Correa *et al.*, 2011). Few studies addressing physicochemical characterization have been conducted with the genus *Psidium*; for example, Correa *et al.* (2011), whose study quantified bioactive compounds in guava and araçá accessions.

However, no reports were found addressing the characterization of guava accessions grafted onto rootstocks resistant to root knot-nematode RKN (*Meloidogyne enterolobii*), considering that the lifespan of guava plants without a resistant rootstock is limited by this pathogen. This study aimed to characterize the physicochemical variability of guava accessions grafted onto a rootstock resistant to the RKN, BRS Guaraçá, to assist in the choice of parents for crosses and the development of new cultivars.

The evaluation was performed in November 2021 in fruits from 87 accessions of an Embrapa *Psidium* Germplasm Bank, Petrolina, PE, Brazil, latitude 09º 08' 12.3" S, longitude 40º 18' 31.6" W, at 363 m above sea level. The guava accessions were collected in some regions of 12 Brazilian States. The accessions were arranged in two blocks, with two plants per plot, in a 4 m x 4 m spacing. The guava BRS Guaraçá, resistant to the RKN, was used as a rootstock. During the harvesting stage, five fruits per plant were randomly chosen from guava accessions and analyzed for eight variables.

Pulp and peel color were determined using a CR-400 colorimeter (Minolta, Tokyo, Japan) as described by Harder *et al.* (2007). Pulp firmness (Newton) was evaluated using a TA.XT.Plus texture meter (Extralab®, São Paulo, Brazil), with an 8 mm tip. The soluble solids were determined using a PAL-1 portable digital refractometer (Atago, São Paulo, Brazil). The solution for titratable acidity (% of citric acid) was quantified as described by Lutz (2008).

The vitamin C, β-carotene and lycopene contents (mg of ascorbic acid per 100 g^{-1}) were determined as described by Correa *et al.* (2011). The variables data, except colors, were subjected to analysis of variance using the general linear model (GLM) procedure of the Statistical Analysis System (SAS), online university version. The data were transformed into square root to meet the assumptions of normality. Histogram charts were constructed using functions of the Microsoft Excel spreadsheet.

There were significant differences ($p< 0.05$) for the fruits of the 87 accessions for all quantitative variables analyzed, indicating phenotypical variability among them. The coefficients of variation ranged from 9.7 to 51.5% for the traits analyzed, indicating good to limited experimental accuracy in data measurement (Table 1). There were no significant differences by the F-test for the variance between plants of the accessions, indicating the absence of phenotypical variability between plants of a given accession (Table 1). For Coser *et al.* (2014), guava is mainly cross-pollinated, expecting high phenotypical variability when multiplied by sexual propagation.

Table 1. Mean squares (MS), mean and coefficient of variation (CV) for pulp firmness, soluble solids (SS), citric acid, vitamin C (Vit C), β-carotene and lycopene measured in fruits from 87 guava accessions grafted onto the BRS Guaraçá rootstock. Petrolina, PE, Brazil.

FV	MS					
	Firmness[1/]	SS[1/]	Citric acid[1/]	Vit C[1/]	#-carotene[1/]	Lycopene[1/]
Block	5.39**	0.09^{NS}	0.03^{NS}	61.5	0.094^{NS}	0.123^{NS}
Accessions	1.26**	0.17**	0.014*	69.4**	0.171**	0.492**

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FV	MS					
	Firmness[1/]	SS[1/]	Citric acid[1/]	Vit C[1/]	#-carotene[1/]	Lycopene[1/]
Variation between	0.004[NS]	0.01[NS]	0.005[NS]	1.1 [NS]	0.218[NS]	0.447[NS]
Variation within	0.55	0.1	0.0117	22.3	0.065	0.125
Range	0-11.31	6.7-16.4	0.16-0.66	33-1335	0.02-1.83	0.0-3.7
Mean	3.7	10.8	0.42	297	0.49	0.77
CV (%)	43.7	9.7	15.7	28	41.2	51.5
Lowest values						
	GUA02MA	GUA178AP	GUA177AP	GUA02MA	GUA131GO	GUA131GO
	GUA105RS	GUA127GO	GUA40PE	GUA113GO	GUA124GO	GUA187ES
	GUA113GO	GUA66RO	GUA145BA	GUA184ES	GUA82RO	GUA46PE
	GUA177AP	GUA07MA	GUA147BA	GUA132RR	GUA35PE	GUA21GO
Highest values						
	GUA87AM	GUA15MA	GUA17MA	GUA07MA	GUA113GO	GUA65RO
	GUA124GO	GUA46PE	GUA15MA	GUA22MA	GUA06MA	GUA150BA
	GUA135RR	PALUMA	GUA31PI	GUA48SE	GUA55SE	GUA32PE
	GUA33PE	GUA69RO	GUA03MA	GUA31PI	GUA73RO	GUA64BA

[NS], [**] and [*]: non-significant, significant at 1% and 5%, respectively by the F-test. [1/]= data transformed into square root.

The pulp firmness values ranged from 0 to 11.31 N, with a mean of 3.7 N and 93% of the accessions showing values from 0 to 8 N (Figure 1A). Overall, 70% of the accessions showed values higher than 10 ºBrix (Figure 1B). Results close to those estimated in the present study were reported by Corrêa *et al.* (2011), who found values ranging from 9.58 to 15.82 ºBrix in guava accessions.

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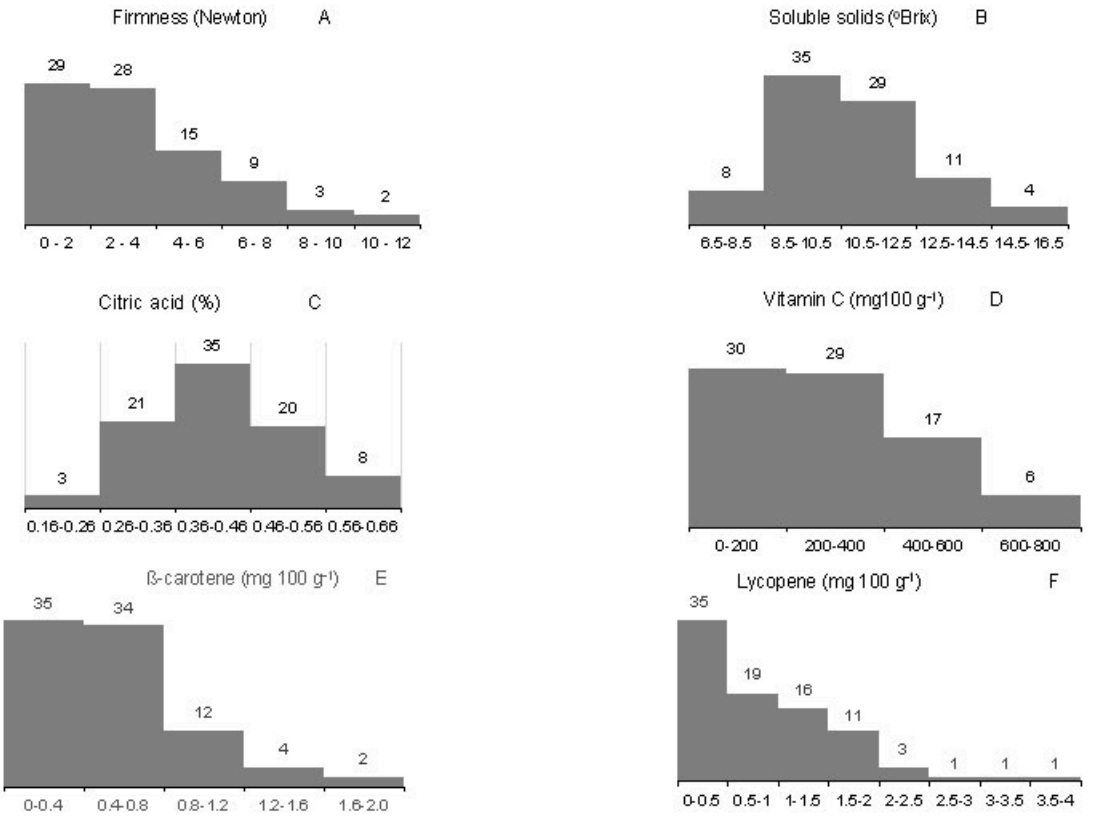
Figure 1. Frequency of accessions for pulp firmness (A), soluble solids (B), citric acid (C), vitamin C (D), β-carotene (E) and lycopene (F) in fruits from 87 guava accessions grafted onto the BRS Guaraçá rootstock.



For citric acid, the values ranged from 0.16 to 0.66%, with a mean of 0.42% (Table 1) and 87% of the accessions showing values ranging from 0.26 to 0.55% (Figure 1C). Corrêa *et al.* (2011) reported values from 0.22 to 0.67% for this compound in guava fruits. The β-carotene contents in the guava accessions analyzed ranged from 0.02 to 1.83 mg 100 g^{-1}, with a mean of 0.49 mg 100 g^{-1} (Table 1).

For lycopene, responsible for the red or pink color of guava, the mean value was 0.77 mg 100 g^{-1} (Table 1), with 93% of the accessions showing values from 0 to 2 mg 100 g^{-1} (Figure 1F). Correa *et al.* (2011) reported higher β-carotene and lycopene contents in guava accessions than reported in ours study.

The mean value for the vitamin C content was 297 mg 100 g^{-1}, with values ranging from 33 to 686 mg 100 g^{-1} (Table 1), with 72% showing values ranging from 33 to 400 mg 100 g^{-1} (Figure 1D). The reported values >600 mg 100 g^{-1} are higher for this crop and characterize excellent ascorbic acid contents for some accessions. Diplock *et al.* (1998) suggested 150 mg as the minimum daily vitamin C intake, which can be supplied with a small part of a fruit of these accessions in a totally natural and healthy way. Corrêa *et al.* (2011) reported values ranging from 44.66 to 409.77 mg 100 g^{-1} when evaluating non-grafted accessions of the same collection of the present study.

The results of the color analyses showed that 95% of the fruits presented a yellow peel color, and only 5% had green fruits in some accessions evaluated. There was great variability in the pulp color parameters, with 55% of the accessions showing a red pulp of different intensities, whereas 9%showed a pink color, 25% had a white pulp of different intensities, and 11% had an orange pulp.

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Two accessions showed higher values for more than one physicochemical; for example, GUA15MA, which showed high values for soluble solids and citric acid and GUA31PI, which showed high contents of citric acid and vitamin C, being indicated for crosses to develop new guava cultivars. The analyses of the present study are innovative as they consider a representative sample of accessions grafted onto BRS Guaraçá. The RKN is the main guava pathogen in Brazil, which has caused severe losses for guava farmers. The guava root system is destroyed by the RKN, leading to plant death in few months and hindering evaluations such as the ones reported in the present study.

Conclusion

The 87 guava accessions evaluated showed significant differences for all quantitative variables analyzed ($p< 0.05$), indicating phenotypical variability among them. The guava accessions GUA33PE and GUA135RR, with high fruit firmness values, are recommended for crosses to develop new cultivars with higher resistance to transport and shelf life. Accessions GUA31PI (886 mg 100 g^{-1}) and GUA48SE (821 mg 100 g^{-1}) showed high values of vitamin C are recommended for crosses aiming at the development of cultivars with higher contents of this bioactive compound.

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