J. Hortic. Sci.
Vol. 18(2) : 282-287, 2023

https://doi.org/10.24154/jhs.v18i2.1435

Original Research Paper

Morpho-biochemical characterization of *Psidium* species

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ABSTRACT

Several *Psidium* species are available with many important traits, lack of intensive characterization limits their use in guava improvement. Therefore, the present study was carried out to characterize five wild *Psidium* species (*P. molle, P. chinensis, P. guineense, P. cattleianum* var. *cattleianum* and *P. cattleianum* var. *lucidum*) and two *P. guajava* genotypes (cv. 'Arka Poorna' and 'H 12-5'), based on morphological and biochemical traits. Among morphological traits, fruit weight was ranged from 5.22 g (*P. cattleianum* var. *cattleianum*) to 225.14 g ('H 12-5'), however, among biochemical traits, highest TSS (12.06 ºBrix) and total sugars (9.98%) were recorded in cv. 'Arka Poorna', while, lowest recorded in *P. cattleianum* var. *lucidum*. Highest ascorbic acid was recorded in *P. chinensis* (205.33 mg/100 g), whereas, lowest recorded in *P. guineense* (60.83 mg/100 g). A positive correlation was observed among wild *Psidium* species but none had correlation with *P. guajava* genotypes for quantitative traits.

Keywords: Ascorbic acid, correlation, guava breeding, *Psidium cattleianum*, *Psidium*

INTRODUCTION

Guava (*Psidium guajava* L.) is the 5th important commercial fruit crops in India. The fruits are rich in carotenoids, lycopene and phenolic compounds (Faraoni et al., 2012), besides having a high level of vitamin A & C, and B complex surpassing the levels found in other fruits (Pommer et al., 2006).

Wild *Psidium* species are having varied potential to be exploited in crop improvement programs. The species *P. guineense* Swartz is found in the coastal areas to high zones of Jalisco (Valera-Montero et al., 2018), while, strawberry guava (*P. cattleianum* var. *cattleianum* Sabine) and lemon guava (*P. cattleianum* var. *lucidum* Sabine) believed to be originated in the lowlands of eastern and southern Brazil to north-east Uruguay. The species *P. molle* is a shrub with profuse flowering, broad leaves with pubescence, small fruits, round with yellow pericarp, whereas, *P. chinensis* is a small shrub with narrowly elliptic leaves and fruits are rich in vitamin C (Banoth et al., 2017).

Moreover, guava scores over other fruits in ascorbic acid, pectin and other mineral contents (Banoth et al., 2017; Kumari et al., 2018). Present study was aimed to characterize wild *Psidium* species and genotypes using morphological and biochemical traits, which could be used in guava breeding.

MATERIALS AND METHODS

The study was carried out at Fruit Crops Laboratory, ICAR-Indian Institute of Horticultural Research, Bengaluru (13° 712 N latitude, 72° 2912 E longitude and 890 above mean sea level) during 2018 to 2020. Experimental material involved five wild *Psidium* species (*P. molle, P. chinensis, P. guineense, P. cattleianum* var. *cattleianum* and *P. cattleianum* var. *lucidum*) and two *P. guajava* genotypes *i.e.* 'Arka Poorna' and 'H 12-5'. Fruits were harvested from a uniform age group (10 to 12 years) of trees maintained in field genebank with uniform package of practices.

Morphological traits

The optimum ripe fruits of *Psidium* species and genotypes were evaluated for morphological traits *viz*., fruit weight (g), fruit volume (mL), fruit diameter (mm), fruit length (mm), fruit girth (mm), pulp thickness (mm), core thickness (mm), weight of 100 seeds (g), total number of seeds, pulp weight (g), seed hardiness (kgf), peel & pulp colour and number of fruits per plant based on guava descriptors (PPV & FRA, 2016). Hardiness of freshly extracted seeds was measured by Vinsyst Hardness Tester. The colour of fruit peel and pulp were described using RHS Colour Chart (RHSC, 2001). Morphological characters of trees were taken as an average of ten plants with three

replications. Data on tree height (m) and plant spread (m) (north-south and east-west) were recorded using meter scale.

Biochemical traits

Biochemical traits *viz*., total soluble solids (°Brix), total sugar (%), reducing sugar (%), non-reducing sugar, ascorbic acid (mg/100 g), acidity (%), carotenoids (mg/100 g) and lycopene (mg/100 g) were estimated in fruit pulp. All biochemical traits were recorded from 10 fruits with three biological replications.

Fruit pulp TSS was measured using a hand refractometer (Anon., 2000) at room temperature (27±2 °C). Total and reducing sugars were analysed by the method of Nelson-Somogyi (1952). Percentage of non-reducing sugars was calculated by subtracting value of the reducing sugars from that of total sugars. The acidity was determined by titration method (Anon., 2000) and ascorbic acid content by DCPIP method (Anon., 2006), while, total carotenoids & lycopene by spectrophotometric method (Lichtenthaler, 1987) under low light condition.

Statistical analysis

Experimental design used was randomized block design with three replications. Mean data was compared by analysis of variance and the Fisher's least significance difference. Pearson's correlation (P=0.01) was performed by using SAS Institute Software (SAS, 2012).

RESULTS AND DISCUSSION

Morphological traits

The data revealed significant and wide variation among wild *Psidium* species and guava genotypes for fruit traits (Table 1 and 2). Highest fruit weight (225.14 g), diameter (85.01 mm), length (77.56 mm), volume (169.89 ml), core thickness (15.94 mm) and pulp weight (184.48 g), girth (314.8 mm), pulp thickness (56.56 mm) were observed in 'H 12-5' followed by 'Arka Poorna', whereas, lowest fruit size was recorded in *P. cattleianum* var. *cattleianum*. The fruits of cultivated guava were, at first sight, bigger, soft seeded and attractive in colour with a pleasant aroma and delicious taste compared to wild *Psidium* species. This difference could be due to selection pressure by human intervention and their genetic makeup (Banoth et al., 2017).

Significantly maximum seeds per fruit (211.60) and seed hardiness (13.04 kgf) was recorded in *P. guineense*, whereas, minimum seed per fruit found in *P. molle* (12.53) and soft seeds recorded in cv. 'Arka Poorna' (4.82 kgf). Maximum weight of 100 seeds was recorded in *P. cattleianum* var. *cattleianum* (4.40 g), whereas, it was minimum in 'Arka Poorna' (0.75 g). Seed number is known to be a function of fertility and effective fertilization (Vishwakarma et al., 2021).

Table 1: Fruit parameters of wild *Psidium* species and genotypes

Species/Genotype	Fruit weight (g)	Fruit volume (ml)	Fruit diameter (mm)	Fruit length (mm)	Fruit girth (mm)	Thickness		Weight of 100 Seeds (g)	Seeds per fruit (Nos.)
						Core (mm)	Pulp (mm)		
Psidium cattleianum var. *lucidum*	9.97^{E}	7.63^{E}	24.39^{D}	25.38^{D}	84.4^{D}	3.23^{D}	19.56^{D}	2.08^{C}	72.00^{D}
P. cattleianum var. *cattleianum*	5.22^{F}	4.79^{E}	20.54^{E}	22.72^{D}	70.0^{E}	2.39^{E}	14.34^{E}	4.40^{A}	26.33^{E}
P. molle	20.39^{C}	15.56^{D}	34.41^{C}	31.46^{C}	113.1^{C}	6.67^{C}	22.80^{C}	3.72^{B}	12.53^{F}
P. guineense	14.96^{D}	12.50^{D}	27.58^{D}	29.35^{C}	94.5^{D}	3.04^{D}	22.55^{C}	0.79^{D}	211.60^{A}
P. chinensis	53.47^{B}	49.09^{C}	44.49^{B}	40.55^{B}	151.1^{B}	6.37^{C}	36.65^{B}	0.78^{D}	188.13^{B}
P. guajava genotype 'H 12-5'	225.14^{A}	169.89^{A}	85.01^{A}	77.56^{A}	314.8^{A}	15.94^{A}	56.56^{A}	0.78^{D}	182.10^{BC}
P. guajava cv. 'Arka Poorna'	221.96^{A}	165.57^{B}	84.14^{A}	77.02^{A}	305.6^{A}	14.98^{B}	54.54^{A}	0.75^{D}	179.10^{C}
SEm±	1.193	1.039	1.062	0.995	0.337	0.160	0.767	0.041	2.489
LSD at 5%	3.674	3.218	3.217	3.065	1.095	0.524	2.190	0.120	7.898
CV (%)	2.82	2.99	4.23	3.97	3.60	3.68	4.09	3.705	3.46

Means with at least one letter common in a row are not statistically significant using Fisher's least significant difference.

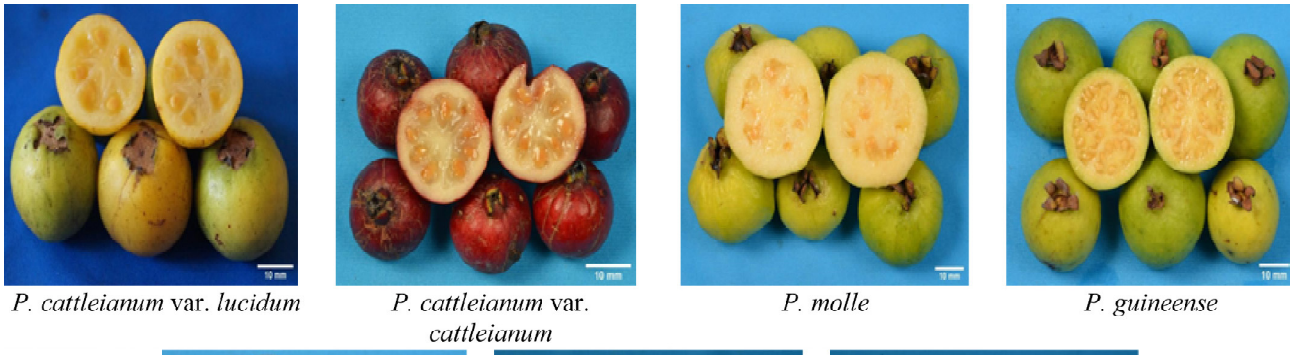

Fig. 1 : Fruits of wild *Psidium* species and genotypes; scale bar: a to e – 10 mm, f and g – 30 mm

Peel colour was yellowish-green in *P. cattleianum* var. *lucidum, P. guineense,* 'H 12-5' and cv. 'Arka Poorna', yellow in *P. molle* and *P. chinensis*, whereas, dark red in *P. cattleianum* var. *cattleianum* at optimum ripe stage (Fig. 1). The species *P. cattleianum* var. *lucidum* and *P. guineense* had yellow-green pulp, light red in *P. cattleianum* var. *cattleianum* and *P. chinensis*, whereas, *P. molle* had yellow colour pulp. 'H 12-5' comes under orange-red colour pulp category, while, 'Arka Poorna' with white pulp. Variation in pulp colour within *P. guajava* genotypes might be due to segregation in F_1 progenies developed from same parents as observed in 'Allahabad Safeda' with white pulp and 'Purple local' with red pulp. Similar variations in fruit characters were also observed by Damiani et al. (2011) and Valera-Montero et al. (2018).

Table 2 : Fruits and plant parameters of wild *Psidium* species and genotypes

Species/Genotype	Pulp weight (g)	Seed hardiness (kgf)	Peel colour	Pulp colour	Plant spread (m)			Fruits per plant (Nos.)
					N-S	E-W	Height	
Psidium cattleianum var. *lucidum*	7.72^{E}	11.31^{C}	YG 150B	YG 145C	2.06^{B}	2.03^{B}	3.00^{B}	2383.33^{B}
P. cattleianum var. *cattleianum*	4.08^{F}	11.83^{B}	Red 46A	Red 56D	2.21^{B}	1.98^{B}	2.77^{BC}	2573.33^{A}
P. molle	15.68^{D}	10.89^{D}	Yellow 11A	Yellow 11C	1.56^{D}	1.66^{C}	4.33^{A}	80.00^{F}
P. guineense	8.25^{E}	13.04^{A}	YG 144A	YG 149D	1.57^{D}	1.70^{C}	1.74^{F}	1946.67^{C}
P. chinensis	46.99^{C}	7.70^{E}	Yellow 11B	Red 47A	1.84^{C}	1.94^{B}	2.52^{D}	376.67^{E}
P. guajava genotype 'H 12-5'	184.48^{A}	4.94^{F}	Y G 150D	Orange Red 34C	2.53^{A}	2.56^{A}	2.24^{E}	770.00^{D}
P. guajava cv. 'Arka Poorna'	176.71^{B}	4.82^{F}	YG 149C	White 155C	2.62^{A}	2.52^{A}	2.74^{CD}	666.67^{D}
SEm±	1.188	0.096	-	-	0.069	0.044	0.073	37.329
LSD at 5%	3.637	0.320	-	-	0.177	0.141	0.228	113.64
CV (%)	3.24	1.81	-	-	5.77	3.74	4.584	5.145

Means with at least one letter common in a row are not statistically significant using Fisher's least significant difference.

Morphological traits

The guava genotypes and wild *Psidium* species showed significant variations for different plant characters. Among all genotypes, plant spread (N-S) ranged from 1.56 m (*P. molle*) to 2.62 m ('Arka Poorna') (Table 2) and plant spread (E-W) ranged from 1.66 m (*P. molle*) to 2.56 m ('H 12-5'). Plant height ranged from 1.74 m (*P. guineense*) to 4.33 m (*P. molle*), while, 'H 12-5' and 'Arka Poorna' recorded maximum plant spread in both directions (N-S and E-W), whereas, minimum plant spread (N-S and E-W) was recorded in *P. molle* with highest upright growth. The species *P. guineense* recorded lowest plant height showing drooping growth pattern. The strong apical dominance in *P. molle* might be a reason for maximum plant height (Deshmukh et al., 2013).

Significantly maximum number of fruits per plant was recorded in *P. cattleianum* var. *cattleianum* (2573.33) followed by *P. cattleianum* var. *lucidum* (2383.33), however, minimum recorded in *P. molle* (80.00). These variations in the bearing of fruits might be due to inherent genetic makeup of the species (Banoth et al., 2017).

Biochemical traits

'Arka Poorna' recorded significantly highest TSS (12.06 ºBrix), total sugar (9.98%), reducing sugar (8.44%) and non-reducing sugar (1.54%) over the other genotypes and wild *Psidium* species (Table 3). TSS was at par with 'H 12-5' followed by *P. molle, P. guineense* and *P. chinensis*. However, lowest TSS (8.83%), total sugar (5.08%), reducing sugar (4.24%) and non-reducing sugar (0.833%) were recorded in *P. cattleianum* var. *lucidum*. Cultivated genotypes might necessitate consumption of nutrients and sinking more carbohydrates into the fruits, thus producing larger fruits with more TSS and sugars. This confirms with the findings of Banoth et al. (2017) and Valera-Montero et al. (2018).

Significantly highest ascorbic acid (230.33 mg/100 g of pulp) was recorded in *P. chinensis* followed by *P. cattleianum* var. *cattleianum* and *P. cattleianum* var. *lucidum* while lowest in *P. guineense* (60.80 mg/100 g), however, lowest acidity was also recorded in *P. guineense* (0.290 %), while, highest in *P. cattleianum* var. *cattleianum* (0.819 %) (Table 3).

Among all guava genotypes and *Psidium* species, 'H 12-5' had higher total carotenoids (5.235 mg/100 g) and lycopene (4.064 mg/100 g) content followed by *P. chinensis*. While, lowest total carotenoids (0.694 mg/100 g of pulp) and lycopene (0.234 mg/100 g of pulp) content were recorded in *P. guineense.* Lycopene has been found to be higher in pink pulp types than white pulp guava which helps in reducing the risk of several chronic diseases (Omoni et al., 2005). The species *P. chinensis* could be explored for vitamin C in daily human diet (Corrêa et al., 2011). The larger variation in biochemical parameters might be due to phenotypic and genetic constitution of the species (Valera-Montero et al., 2018).

Correlation analysis of quantitative traits

P. cattleianum var. *lucidum* showed positive correlation with *P. cattleianum* var. *cattleianum*,

Table 3 : Biochemical parameters of fruits of wild *Psidium* species and genotypes

Species/Genotype	TSS (ºBrix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100 g)	Acidity (%)	Carotenoids (mg/100 g)	Lycopene (mg/100 g)
Psidium cattleianum var. *lucidum*	8.83^{D}	5.08^{G}	4.24^{F}	0.833^{E}	207.33^{BC}	0.632^{C}	0.756^{C}	0.317^{C}
P. cattleianum var. *cattleianum*	9.92^{C}	5.62^{F}	4.70^{E}	0.923^{D}	210.67^{B}	0.819^{A}	0.789^{C}	0.379^{C}
P. molle	10.88^{B}	5.76^{E}	4.83^{D}	0.923^{D}	88.93^{E}	0.326^{E}	0.618^{D}	0.358^{C}
P. guineense	10.84^{B}	7.94^{D}	6.97^{C}	0.967^{D}	60.83^{F}	0.290^{F}	0.449^{E}	0.234^{D}
P. chinensis	10.76^{B}	8.11^{C}	6.99^{C}	1.117^{C}	230.33^{A}	0.726^{B}	4.037^{B}	3.268^{B}
P. guajava genotype 'H 12-5'	11.76^{A}	8.63^{B}	7.44^{B}	1.190^{B}	189.47^{D}	0.467^{D}	5.235^{A}	4.064^{A}
P. guajava cv. 'Arka Poorna'	12.06^{A}	9.98^{A}	8.44^{A}	1.540^{A}	205.33^{C}	0.475^{D}	—	——
SEm±	0.136	0.031	0.027	0.018	1.304	0.005	0.009	0.013
LSD at 5%	0.439	0.103	0.085	0.058	4.185	0.016	0.038	0.072
CV (%)	2.194	0.73	0.75	2.904	1.326	1.602	0.807	1.512

Means with at least one letter common in a row are not statistically significant using Fisher's least significant difference.

Table 4 : Correlation analysis of *Psidium* species and guava genotypes

Species/Genotype	*P. cattleianum* var. *lucidum*	*P. cattleianum* var. *cattleianum*	*P. molle*	*P. guineense*	*P. chinensis*	*P. guajava* genotype 'H 12-5'	*P. guajava* cv. 'Arka Poorna'
Psidium. cattleianum var. *lucidum*	1						
P. cattleianum var. *cattleianum*	0.899**	1					
P. molle	0.724	0.933**	1				
P. guineense	0.854**	0.545	0.267	1			
P. chinensis	0.924**	0.699	0.526	0.926**	1		
P. guajava genotype 'H 12-5'	0.625	0.583	0.657	0.450	0.742	1	
P. guajava cv. 'Arka Poorna'	0.626	0.582	0.655	0.455	0.745	0.999**	1

P. guineense and *P. chinensis* (Table 4). Similarly, *P. cattleianum* var. *cattleianum* registered significant positive correlation with *P. mole*, while, *P. guineense* with *P. chinensis*. Wild species did not register any correlation with *P. guajava* genotypes ('H 12-5' and 'Arka Poorna') but registered high correlation with each other. Similarly, Kumari et al. (2018) also reported positive correlation in morphological parameters among cultivated varieties.

CONCLUSION

The wild species of *Psidium* are good source of ascorbic acid (*P. chinensis*) and heavy bearing (*P. guineense*). Strong correlation existed among wild species for quantitative traits but no correlation existed between *P. guajava* and wild *Psidium* species. The wild species could be exploited in crop improvement for imparting the traits *viz.*, heavy bearing, high ascorbic acid content and dwarf stature.

ACKNOWLEDGEMENT

Authors are thankful to the Director, ICAR-Indian Institute of Horticultural Research, Bengaluru, India for providing the facility. The first author is grateful for the financial support provided by the DST-INSPIRE, Ministry of Science & Technology, Government of India.

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(Received : 13.11.2023; Revised : 01.12.2023; Accepted : 05.12.2023)