

Research Article

Characterization of F1 Hybrids of Guava (*Psidium Guajava* L.) on the Basis of Phenotypic and Biochemical Parameters

Harjot Singh Sohi*, Manav Inder Singh Gill, Daljinder Singh and Naresh Kumar Arora

Department of Fruit Science, Punjab Agricultural University, Ludhiana, Punjab, India - 141 004

Abstract

Fruit quality in relation to pulp color is one of the advance objectives which will kept in mind while going for guava improvement programme. Guava has a fairly rich varietal diversity in relation to pulp colour. Earlier approaches are made to attain more desirable yield characters for the improvement of specific traits, viz., fruit size, fruit shape, fruit length, fruit breadth, appropriate TSS, high ascorbic acid, etc. In the present study, maximum total soluble solids (TSS, 12.8°Brix) and juiciness (54.27%) in hybrid H1. No significant ($P>0.05$) differences between guava genotypes in relation to fruit length and width size, and Vitamin-C content of hybrids was observed. However, leaf blade length (cm) and width (cm) was maximum in hybrid H3. Hybrid H1, the fruits were of medium and uniform in size. Vitamin C content (299.13) was found maximum in H1 and minimum in H6 (155.82). In conclusion, among the eight hybrids evaluated, hybrid H1 (Allahabad Safeda \times CISH-G1) was found to be superior in terms of morphological and physico-chemical characters fruit was found to be the best.

Keywords: Hybrid, Leaf shape, Juiciness, Guava and Vitamin C

*Correspondence

Author: Harjot Singh Sohi

Email: harjotsinghsohi@gmail.com

Introduction

Guava (*Psidium guajava*), believed to be originated in Central America [1], is well-adapted in India and is now grown throughout the country. Guava is a good source of calcium and iron, having 2–5 times more vitamin-C content than that of citrus, and contains β -carotene, lycopene carotenoids and phenolic compounds [2, 3]. Area and production of guava fruit in state Punjab (India) is 9142 hectare and 206106 MT, respectively by Punjab Horticulture Mission [4]. In India, a huge genetic diversity exists in Indo-Gangetic plains which facilitated development of new varieties in guava [5]. Commercial varieties (red and white flesh) which are only available in India were studied [6]. The adaption and changes in various physico-chemical parameters in guava hybrids were studied and compared with germplasm of diverse origin, landraces and wild species of guava [7]. It has been reported that in guava fruit, the level of total soluble solids (TSS) ranged from 9.6 to 11.14 °Brix, titratable acidity from 0.28 to 0.38%, ascorbic acid content from 167.50 to 210.00 mg/100 g edible portion, total sugar from 7.93 to 8.90%, and reducing sugar from 5.04 to 5.49% [8, 9]. Usually, the easiest assessment of genetic variation is through morphological or phenotypic measures. UPOV descriptors are an important means for the characterization of guava worldwide and provide an easy and rapid way to discriminate between guava phenotypes. The descriptors generally include highly heritable traits that can be easily detected visually.

Maintaining of guava germplasm lines is necessary to reduce the risk in association to the outbreaks of various diseases and pests attack. In order to complement the morphology based description, molecular markers were used to assess genetic variability and DNA-based markers [10]. The objective of the present study is to evaluate true guava hybrids on the basis of morphological and physio-chemical characters.

Material and Methods

Guava genotypes

Eight guava hybrids were evaluated for different morphological and physico-chemical traits (**Table 1**).

These hybrids were planted at a spacing of 6 x 6 m at New Orchard, Department of Fruit Science, Punjab Agricultural University, Ludhiana, Punjab by [11]. During the course of investigations, all the trees received recommended doses of fertilizers and other cultural practices as per University package and practices.

Table 1 Different guava cross combinations evaluated in the present study

S. No.	Hybrid*	Crossing parents
1	H1	Allahabad Safeda × CISH G-1
2	H2	CISH G-1 × 1716
3	H3	CISH G-4 (Shewta) × 1716
4	H4	CISH G-4 (Shewta) × Malaysian guava
5	H6	CISH G-1 × Allahabad Safeda
6	H7	CISH G-1 × L-49 (Sardar Guava)
7	H8	Safri × CISH G-1
8	H9	Safri × Malaysian guava

*H5 [L-49 (Sardar Guava) × CISH G-1] failed to survive in field conditions.

Morphological evaluation of F1 hybrids

Morphological evaluations were carried out regularly for two years (2014-15 to 2015-16). The data for yield and quality parameters was recorded from fruits at full maturity. Twenty fruits were sampled from each hybrid for quality analysis, and evaluated for fruit weight, core diameter, longitudinal ridge, relief on fruit surface, fruit size, total soluble solids (TSS), titratable acidity and ascorbic acid as per standard methods described by [12]. In addition, leaf parameters such as colour of young twig, anthocyanin colouration of young leaf, undulation of the margin, colour of midrib, leaf base shape, leaf shape, leaf apex shape, leaf length/width ratio and petiole length from individual hybrids were recorded on the basis of International Union for the Protection of New Varieties of Plants (UPOV) descriptors (1987).

Statistical analysis

Design of experiment was in randomized block with five replications. Data was subject for analysis of variation by one way ANOVA. Statistical analysis was performed using analysis of variance. Probability value of $p \leq 0.05$ was considered as significant. Rating of various characters was done in accordance with 'Guava Descriptor' published by All India Coordinated Research Project on Subtropical Fruits (AICRP-STF), CISH, Lucknow in the year 2011. The base and apex of leaf was observed visually and it was classified as round, acute and obtuse [13].

Results and Discussion

Evaluation of hybrids

Leaf characters

The data with respect to colour of midrib, undulation of the margins, shape of mature leaf, leaf base and leaf apex were recorded among different hybrids and presented in **Table 2**. Light pink coloured midrib was noticed in H1 and H9 and light green coloured midrib in rest of hybrids. The fully mature leaf shape in hybrids H4, H6 and H7 was elliptical, H2 and H9 leaves were oblanceolate, H3 and H8 were Obovate, whereas H1 had oblong shaped. Undulation of the leaf margin was observed only in H1, H2 and H4. Leaf base was obtuse in hybrids H1, H2, H6, H7 and H9, whereas, H3, H4 and H8 had round leaf base shape. Leaf apex shape was obtuse in hybrids H1, H4, H8; round in H3, H6, H7 and acute in H2, H9. Leaf shape and pattern were studied for variation among different *Psidium* genotypes. Obtuse leaf apex was recorded earlier in Allahabad Safeda and L-49[14].

Table 2 Phenotypic characters of Leaf of different hybrids of guava

Hybrids	Colour of midrib	Leaf base shape	Leaf shape	Leaf apex shape	Undulation of the margin	Leaf Length (mm)	Leaf Width (mm)
H1	Light Pink	Obtuse	Oblong	Obtuse	Present	121.83 ^b	54.35 ^b
H2	Green	Obtuse	Oblanceolate	Acute	Present	127.00 ^{ab}	41.43 ^c
H3	Light Green	Round	Obovate	Round	Absent	131.61 ^a	59.18 ^a
H4	Light Green	Round	Elliptical	Obtuse	Present	94.89 ^d	55.25 ^b
H6	Light Green	Obtuse	Elliptical	Round	Absent	100.27 ^d	48.41 ^c
H7	Light Green	Obtuse	Elliptical	Round	Absent	112.64 ^c	50.75 ^c
H8	Light Green	Round	Obovate	Obtuse	Absent	125.43 ^{ab}	50.33 ^c
H9	Light Pink	Obtuse	Oblanceolate	Acute	Absent	121.31 ^b	44.79 ^d
Mean	N/A	N/A	N/A	N/A	N/A	116.87	50.56
LSD($p \leq 0.05$)	N/A	N/A	N/A	N/A	N/A	10.09	3.349

Among different hybrids, maximum mean leaf blade length (mm) was found in H3 (131.61) followed by H2 (127.00) and H1 (125.43) and the minimal leaf length of 94.89 mm was recorded in H4. Mean leaf width (mm) was found maximum in H3 (59.18) followed by H4 and H1 (55.25 and 54.35, respectively). Similarly, leaf and fruit characters of guava genotypes were studied and significant variation was recorded between different leaf characters [15-17].

Fruit Characters

Fruit shape was sub-globose in Hybrid H1, H2, H7 and H9; transversely elliptic in hybrid H4, H6 and H8; whereas, pyriform in H3 (**Table 3; Figure 1**). The fruit shape at stalk end was necked in H3, whereas, rounded to broadly rounded in rest of hybrids. However, the fruit apex shape was broadly rounded in hybrids H1, H2, H3 and H7, and flattened in H4, H6, H8 and H9. The longitudinal ridges are rounded in H1, H2, H7, H8 and H9; broadly rounded in H4 and H6, whereas, necked in H3. The fruit surface in different hybrids ranged from sub-globose to pyriform to transversely elliptic; longitudinal ridges were rounded or necked; fruit surface varied from smooth to bumpy surface was observed in guava genotypes by [18].















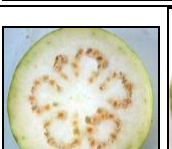

Hybrid (Parents crossed)	Fruit phenotypic characters		Hybrid (Parents crossed)	Fruit phenotypic characters	
H1 Allahabad Safeda × CISH G-1			H6 CISH G-1 × Allahabad Safeda		
H2 CISH G-1 × 1716			H7 CISH G-1 × L-49 (Sardar Guava)		
H3 CISH G-4 (Shweta) × 1716			H8 Safri × CISH G-1		
H4 CISH G-4 (Shweta) × Malaysian Guava			H9 Safri × Malaysian Guava		

Figure 1 Flesh colour and apex shape of fruits obtained from eight different cross combinations of guava

The maximum fruit length (mm) was observed in hybrid H6 and H7 (72.57 and 72.03, respectively) and maximum width (mm) in hybrid H7 (106.59). Change in geographical location/inherent genetic characters were the reasons behind variation in fruit length and width among different genotypes [19-22].

The percent TSS was found maximum in hybrid H1 (12.82) and H6 (12.54) followed by H3 (11.63) and lowest in H7 and H8 (9.17 and 9.26, respectively) (**Table 4**). Similarly, results were carried out in which the flesh color was pink in Lalit, red in Red Fleshed with highest TSS but lower in pectin content as compared to green skin guava was observed by [23]. Although, no significant difference was recorded in acidity of different hybrids, the acidity was numerically highest in hybrid H2 (0.481) followed by H7 (0.454) and lowest in H6 (0.297). The percent juiciness was maximum in H1 (54.27) followed by H6 (53.29) and H9 (52.62), whereas, lowest in H3 (44.38). Furthermore, the vitamin C content (mg/100 g edible portion) was highest in hybrid H1 (299.13) followed by H4 (280.33) and lowest in H9 (182.01) (**Table 4**).

Correlation among various fruit traits

Correlation coefficients estimation indicates that fruit weight expressed highly significant and positive correlation with fruit width ($r = 0.892^{**}$). Showed a negative correlation of Vitamin C with respect to fruit length, fruit width, TSS, acidity and juiciness (**Table 5**). Juiciness % showed significant and positive correlation ($r=0.549^*$) with fruit

length and merely significant correlation ($r = 0.409$) with fruit width showed that with increase in fruit size the juiciness percentage was also increased. [24-26] also compared the phenotypic and chemical parameters correlation coefficient in guava fruits.

Table 3 Phenotypic parameters of fruit of different hybrids of guava

Hybrids	Fruit shape	Fruit shape at stalk end	Fruit apex shape	Longitudinal ridges	Fruit length (mm)	Fruit width (mm)
H1	Sub-globose	Rounded	Broadly rounded	Rounded	69.72 ^{bc}	77.83 ^d
H2	Sub-globose	Rounded	Broadly rounded	Rounded	67.88 ^{de}	71.39 ^e
H3	Pyriform	Necked	Broadly rounded	Necked	66.72 ^e	69.42 ^f
H4	Transversely elliptic	Broadly rounded	Flattened	Broadly rounded	70.74 ^b	81.47 ^c
H6	Transversely elliptic	Broadly rounded	Flattened	Broadly rounded	72.57 ^a	93.00 ^b
H7	Sub-globose	Rounded	Broadly rounded	Rounded	72.03 ^a	106.59 ^a
H8	Transversely elliptic	Rounded	Flattened	Rounded	67.36 ^c	70.87 ^{ef}
H9	Sub-globose	Rounded	Flattened	Rounded	68.80 ^{cd}	77.00 ^d
Mean	N/A	N/A	N/A	N/A	69.48	80.94
LSD ($p \leq 0.05$)	N/A	N/A	N/A	N/A	0.588	0.872

Table 4 Chemical attributes of fruit of different hybrids of guava

Hybrids	TSS	Acidity	Juiciness %	Vitamin C
H1	12.82 ^a	0.298	54.27 ^a	299.13 ^a
H2	9.81 ^c	0.481	49.76 ^c	254.11 ^c
H3	11.63 ^b	0.400	44.98 ^h	207.44 ^d
H4	9.64 ^c	0.374	47.57 ^g	280.33 ^b
H6	12.54 ^a	0.297	53.29 ^b	155.82 ^f
H7	9.17 ^c	0.454	51.04 ^d	183.16 ^e
H8	9.26 ^c	0.402	48.57 ^f	210.53 ^d
H9	11.47 ^b	0.394	52.62 ^c	182.01 ^e
Mean	10.79	0.378	50.26	221.56
LSD ($p \leq 0.05$)	1.004	0.700	0.315	0.346

Table 5 Correlation coefficient analysis of fruit characters

Correlation	Fruit length (mm)	Fruit width (mm)	TSS (° Brix)	Acidity	Juiciness %
Fruit width (mm)	0.892**				
TSS	0.104	-0.111			
Acidity	-0.371	-0.055	-0.777		
Juiciness %	0.549*	0.409	0.471	-0.462	
Vitamin C (mg/100 g)	-0.221	-0.408	-0.031	-0.081	-0.082

* and ** at 5% and 1% level of significance, respectively

To summarize, among the F_1 hybrid progeny evaluated for morphological and fruit characters, the hybrid H1 (Allahabad Safeda \times CISH-G1) was found to be the best. It has maximum total soluble solids, vitamin-C and percent juiciness. The fruits of this hybrid had deep pink flesh colour as compared to white-cream flesh colour in other hybrids.

References

- [1] Hayes, W.B. (1953). Fruit Growing in India. Kitabistan, Allahabad
- [2] Singh, G. (2005). Strategies for improved production in guava. In: Kishun R, Mishra AK, Singh G, Chandra R. Proc 1st Int Guava Symp. pp 26–39. CISH, Lucknow, India.
- [3] Joseph, S., Chatli, M.K., Biswas, A.K. and Sahoo, J. (2012). Efficacy of pink guava pulp as an antioxidant in raw pork emulsion. J. Food Sci. Tech. DOI: 10.1007/s13197-012- 0668-1.

- [4] <https://punjabhorticulture.com/Documents/Crops/Fruits/Fruits%202018-19.pdf>
- [5] Rajan, S., Yadava, L.P., Kumar, R. and Saxena, S.K. (2007) GIS based diversity analysis of guava growing distribution in Uttar Pradesh. *Acta Horti*. 735: 109-13.
- [6] Pommer, C. V. and Murakami K. R. N. (2009). Breeding Guava (*Psidium guajava L.*). Book: Chapter.
- [7] Bhalekar, S.G. and Chalak, S.U. (2017). Studies on performance of different guava cultivars under western Maharashtra conditions. *Electron. J. Plant. Breed.* 8(2): 577-579.
- [8] Archana, A., Siddique, S. (2004). Bio chemical changes in guava fruits under various modified conditions. *J. Hort Sci.* 33: 209-212.
- [9] Aulakh, P.S. (2004). Effect of seasonal variation on yield and fruit quality of some promising guava cultivars under ARId irrigated region of Punjab. *Haryana J. Hort. Sci.* 33: 170-171.
- [10] Aranguren, Y., Valecillos, C. and Fermin, G. (2010). Variability of Venezuelan Guava Geographic Landraces Employing Phenotypic Markers. *Acta Horti*. 849.
- [11] Singh, A., Kumar, S., Kulloli, R. N. (2016). Performance Evaluation of Guava (*Psidium guajava L.*) Introductions in ARId Conditions of Western Rajasthan. *Annals of Arid Zone*. 55(1&2): 25-28.
- [12] Ranganna S. (1986). Hand book of analysis and quality control for fruits and vegetables products. Tata Mc Graw Hill Publishing Co Ltd, New Delhi, India.
- [13] Dutta, A. C. (1996). Botany for Degree Students, pp 25-46 Oxford University Press.
- [14] Mani, A., Mishra, R., Thomus, G. (2011). Elucidation of Diversity among *Psidium* species using morphological and SPAR methods, *Journal of Phytology*. 3(8): 53-61.
- [15] Jana, B. R., Munsu, P. S., Mgnna, D. C. and Das, B. (2010). Evaluation of Guava (*Psidium guajava L.*) Genotypes Based on Fruit Morphology, Physico-chemical Properties and Yield under Eastern Plateau Condition. *Indian J. Plant Genet. Resour.* 23(I): 25-29.
- [16] Shiva, B., Nagaraja, A., Srivastav, M., Kumari, S., Goswami, A.K., Singh, R. and Arun, M. B. (2016). Characterization of guava (*Psidium guajava*) germplasm based on leaf and fruit parameters. *Ind. J. Agri. Sci.* 87(5): 634-8.
- [17] Mehta, S. K., Singh, K. K., Rana, D. K., Bhartwal, P. and Brahmanand (2018). Evaluation of Physico-Chemical Parameters of different Varieties of Guava (*Psidium guajava L.*) under Sub-tropical Condition of Garhwal Himalaya (Uttarakhand), India. *International Journal of Advanced Scientific Research and Management. Special Issue I*.
- [18] Sharma, A., Sehrawat, S. K., Singhrot, R. S. and Tele, A. (2010). Morphological and chemical characterization of *Psidium* Species. *Not Bot Hort Agrobot Cluj*. 38(1): 28-32.
- [19] Pandey, D., Shukla, S. K., Yadav, R. C. and Nagar, A. K. (2007). Promising guava (*Psidium guajava L.*) cultivars for North Indian conditions. *Acta Hort*. 735: 91-94.
- [20] Phadnis, N. A. (1970). Improvement of guava (*Psidium guajava L.*) by selection in Maharashtra. *Ind. J. Hort.* 27: 99 -105.
- [21] Thonte, G. T. and Chakrawar, V. R. (1982). Physico-chemical characters of the certain types/ strains of guava (*Psidium guajava L.*). *Prog. Horti*. 14: 269-72.
- [22] Biradar, S. L. and Mukunda, G. K. (2007). TG Seln. 5/12 – A promising genotype of Taiwan Guava from Bangalore. *Acta Hort*. 735: 85-9.
- [23] Singh, A., Kumar, S., Kulloli, R. N. (2016). Performance Evaluation of Guava (*Psidium guajava L.*) Introductions in ARId Conditions of Western Rajasthan. *Annals of Arid Zone*. 55(1&2): 25-28.
- [24] Raghav, M. and Tiwari, J. P. (2008). Genetic variability and correlation analysis in guava. *Ind. J. Horti*. 65: 263-70.
- [25] Bihari, M. and Suryanarayan (2011). Genetic diversity, heritability, genetic advance and correlation coefficient in guava (*Psidium guajava*). *Ind J. of Agri. Sci.* 81: 107-110.
- [26] Jat, K. C., Bhatnagar, P., Kumar M. and Choudhary, K. C. (2018). Correlation dynamics under survey of physicochemical characters of guava (*Psidium guajava L.*) cv.L-49 growing in jhalawar district. *Int. J. Sci., Environ.* 7, 153-159.

© 2019, by the Authors. The articles published from this journal are distributed to the public under “Creative Commons Attribution License” (<http://creativecommons.org/licenses/by/3.0/>). Therefore, upon proper citation of the original work, all the articles can be used without any restriction or can be distributed in any medium in any form. For more information visit www.chesci.com.

Publication History

Received	01.05.2019
Revised	20.12.2019
Accepted	23.12.2019
Published	23.12.2019