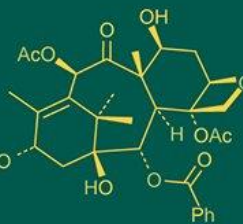
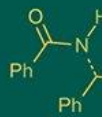


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Assessment of genetic variability, heritability and genetic advance associated with biochemical and yield contributing characteristics in guava (*Psidium guajava* L.) genotypes

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Abstract

The experiment entitled “Assessment of genetic variability, heritability and genetic advance associated with biochemical and yield contributing characteristics in guava (*Psidium guajava* L.) genotypes” was conducted during 2025-26 at the Experimental Farm, Western Block, Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The present investigation was undertaken to evaluate the performance and variability among 27 guava (*Psidium guajava* L.) genotypes along with one check variety (L-49) under the agro-climatic conditions of Akola. The present investigation was undertaken to assess the magnitude of genetic variability, heritability and genetic advance for important fruit and quality traits among 27 guava genotypes. Considerable variability was observed among the genotypes for fruit and quality attributes ranging from minimum to maximum. Fruit length ranged from 5.70 to 8.40 cm, fruit breadth (5.29 to 7.99 cm), fruit diameter (5.40 to 8.10 cm), fruit volume (116.12 to 284.26 cc), fruit weight (135.78 to 287.62 g), pulp weight (110.82 to 255.69 g), seed weight (3.30 to 4.54 g) and fruit yield (10.45 to 23.66 kg plant⁻¹). Among the quality and biochemical traits, substantial variation was observed for TSS, sugars, titratable acidity, ascorbic acid, pectin and protein content. The genotypic coefficients of variation were generally close to the corresponding phenotypic coefficients of variation, indicating limited environmental influence on trait expression. High heritability was recorded for most of the traits, particularly fruit volume (98.25%), fruit yield (98.26%), fruit breadth (95.57%), fruit diameter (95.00%), fruit weight (97.54%), pulp weight (97.63%) and ascorbic acid content (96.61%). High genetic advance as a percentage of mean was observed for fruit yield (33.64%), fruit volume (32.08%), pulp weight (28.40%) and fruit weight (25.84%), indicating substantial scope for improvement through selection. Protein content exhibited moderate variability with high heritability (77.24%) and a genetic advance of 8.00%. Overall, the high heritability coupled with moderate to high genetic advance observed for major fruit traits indicated a strong genetic contribution to their expression and suggested that direct selection would be effective for improving fruit size, pulp yield and productivity in guava.

Keywords: Guava, genotypes, biochemical traits, genetic variability, heritability & genetic advances

Introduction

Guava (*Psidium guajava* L.) is considered the fourth most significant fruit crop worldwide, following mango, banana, and citrus in terms of both cultivation area and overall production. This fruit is native to Tropical America, with its natural distribution extending from Mexico to Peru. The introduction of guava to regions outside its native habitat was aided by early Spanish and Portuguese explorers, who brought it to various parts of the globe, including India, where it was first documented in the 17th century. (Doljode, 2001) [3]. Guava is recognized for its remarkable nutritional profile. It is low in both calories and fats, while serving as a rich source of vital vitamins, minerals, and phytochemicals, including antioxidant polyphenols and flavonoids. (Anon, 2014) [1]. These components are widely recognized for their contribution to lowering the risk of chronic illnesses such as cancer, enhancing the immune system, and slowing down the aging process. The fruit serves as a rich source of dietary fiber (5.4 g /100 g), which is advantageous for digestive health and acts as a natural laxative. Furthermore, guava is an exceptionally potent source of vitamin C,

particularly concentrated in the outer rind, which contains significantly higher levels of vitamin C compared to the inner pulp. This vitamin boosts the body's defence against infectious agents and neutralizes harmful free radicals linked to cancer development. Guava fruits exhibit a range of shapes, including round, oval, or pear-like forms, and typically measure between 2 to 4 inches in length. The apex of the fruit often retains remnants of the floral sepals. There is significant variability among cultivars in terms of taste, pulp texture, and seed hardness. The most favoured varieties are those with thin, edible skins, creamy and flavourful flesh, and soft, chewable seeds. The flesh can be white, pink, yellow, or even red, and the fruit is renowned for its unique sweet, musky fragrance (Sharma *et al.*, 2009; Mitra and Bose, 2001; Subramanyam and Iyer, 1993) [17]. Despite the agronomic significance of guava, research focusing on genotypic and phenotypic variability is rather scarce. The findings of this research are anticipated to yield valuable insights into the inheritance patterns of essential traits and to identify superior genotypes for application in guava breeding and crop enhancement programs.

Materials and Methods

The present investigation entitled "Assessment and characterization of biochemical traits in guava (*Psidium guajava* L.) genotypes" was carried out during the year 2025-2026 at the Experimental Field, Western Block, Central Research Station (CRS), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The study involved 26 local guava genotypes along with a check variety, L-49. Observations were recorded on a single plant per genotype during the *Mrig bahar* season under single-season evaluation.

TSS (⁰ Brix)

For estimation of TSS, the samples were grounded in mortar and pastel and the juice was extracted with the help of muslin cloth and total soluble solids was determined with help of digital refractometer (ATAGO, RX-7000X) and expressed as total soluble solids in "Brix".

Total Sugars (%)

For estimating of total sugars extract was prepared from selected fruit pulp total sugars were determined by "Dubois method" (Sadasivam and Manickam, 1996) [21]. In this method 5 per cent phenol and 96 per cent conc. H₂SO₄ was used to carry out the analysis absorbance of the samples was noted at 490 nm on PC based double beam spectrophotometer (Systronics, 2022) and graph values were put in the following formula.

Procedure

From above 100 times diluted juice 1 ml was taken in a 50 ml volumetric flask and volume was made up with distilled water (5000 times dilution). From this 1ml juice was taken, to that 1 mole 5 per cent phenol and 5 ml of 96 per cent conc. H₂SO₄ was added and the absorbance of the samples was noted at 490 nm on PC based double beam spectrophotometer (Systronics 2202) and graph values were put in the following formula.

Calculation: Total sugars (%)

$$\text{Reading from graph } (\mu\text{gml}^{-1}) \times \frac{1}{1000000} \times \frac{100 \times 50}{1} \times \frac{50}{1} \times \frac{100}{\text{wt. of sample taken}}$$

Non-Reducing Sugars (%)

Non reducing sugars content was determined by subtracting the value of reducing sugars from total sugars.

$$\text{Non - Reducing sugars (\%)} = [\text{Total sugars (\%)} - \text{Reducing sugars (\%)} \times 0.95]$$

Reducing Sugars (%)

For estimating reducing sugars extract was prepared from selected fruit pulp, reducing sugars was determined by "Dubois method". In this method DNS reagent prepared by dissolving 1g dinitro salicylic acid, 200 mg crystalline phenol and 50 mg sodium sulphate in 100 ml of 1% NaOH and was used immediately after preparation.

Procedure

For estimation samples were grounded in mortar and pastel and the juice was extracted with the help of muslin cloth. This juice was diluted 100 times i.e. 1 ml juice diluted to 100 ml distilled water in volumetric flask (100 times dilution) and from this diluted juice 1 ml was taken, to that 2 ml DNS reagent was added then the mixture was boiled for 8-10 minute on hot water bath and the absorbance of the sample was noted at 540 nm on PC based double beam spectrophotometer and graph values were put in to following formula.

Calculation: Reducing sugars (%)

$$\text{Reading from graph } (\mu\text{gml}^{-1}) \times \frac{1}{1000000} \times \frac{100 \times 50}{1} \times \frac{50}{1} \times \frac{100}{\text{wt. of sample taken}}$$

Titrateable Acidity (%)

The total titrateable acidity of guava pulp samples was determined by visual titration method (Ranganna, 1991) [15], as narrated below.

Preparation of sample

Ten grams of pulp was taken in a 100 ml beaker and a little quantity of distilled water was added to it. Transferred into a 100 ml volumetric flask and the volume was made up. The pulp was filtered using Whatman No.4 filter paper and the filtrate was used for analysis.

Procedure

Ten ml of filtrate was taken in a conical flask and titrated against 0.1N NaOH solution using 1 or 2 drops of phenolphthalein indicator. Formation of pink colour was reckoned as the end point of titration. Then, the acidity, expressed as the percentage of anhydrous citric acid, was calculated as follows:

Calculation

Titrateable acidity =

$$\frac{\text{Titre value} \times \text{N of NaOH} \times \text{Volume made up} \times \text{Equivalent weight of citric acid}}{\text{Volume of sample} \times \text{Weight of sample taken for titration} \times 1000} \times 100$$

Ascorbic Acid (mg/100g)

Vitamin C (Ascorbic acids) content of guava pulp samples was determined by 2, 6-dichlorophenol indophenol visual titration method (Ranganna, 1991) [15], as detailed here under.

Preparation of 2, 6-dichlorophenol indophenol dye solution

In a beaker, 50 mg of sodium salt of 2, 6-dichlorophenol indophenol dye and 42 mg sodium bicarbonate were dissolved using 150 ml hot distilled water. Then, the volume was made up to 200 ml with distilled water. Oxalic acid (0.4%) Four g of oxalic acid was dissolved in 100ml of distilled water and volume made up to 1000 ml with distilled water.

Standard ascorbic acid

Hundred milligrams of L-ascorbic acid was dissolved in a small quantity of 0.4 per cent oxalic acid in a 100 ml volumetric flask and the volume was made up by the oxalic acid. 10 ml of this solution was diluted to 100 ml using the oxalic acid. Therefore, the standard ascorbic acid contained 0.1 mg of ascorbic acid per ml solution.

Standardization of dye

Five ml of standard ascorbic acid solution and 5 ml of 0.4 per cent oxalic acid were taken in a conical flask, and titrated against the dye solution. The end point was light pink colour which persisted for at least 5 -10seconds. The dye factor was then calculated as follows:

$$\text{Dye value} = \frac{0.5}{\text{Titre value}}$$

Preparation of sample

Ten grams of pulp was taken in a 100 ml volumetric flask and 50 ml of 0.4 per cent oxalic acid was added. The sample was thoroughly mixed and the volume was made up to the mark using the acid mixture. The solution was filtered using Whatman No. 4 filter paper and the filtrate was used for analysis.

Procedure

Five ml of filtered sample and 0.4 per cent oxalic acid were taken in a conical flask and titrated against the standard dye solution. The end point was light pink colour, which persisted for 5-10seconds.

Calculation

$$\text{Ascorbic acid} = \frac{\text{Titre value} \times \text{dye factor} \times \text{volume made up}}{\text{volume taken} \times \text{weight of pulp for titration}} \times 100$$

Pectin content (%)

Pectin extracted from the plant material is saponified with alkali and precipitated from an acid solution as calcium pectate by the addition of calcium chloride. The total pectin as percentage of calcium pectate was estimated by the method explained by Ranganna, 1991^[15].

Procedure

Fifty grams of pulp was taken in 1000 ml beaker. Total 400 ml of 0.05 N HCl was added and the content was heated for 2h at 80-90 °C, then the content was cooled and it was transferred to 500 ml volumetric flask and the volume was made up with distilled water. Hundred ml of aliquot was taken and 250 ml of distilled water was added to that, then the content was neutralized with the help of 10 ml 1 N NaOH using phenolphthalein as indicator and it was allowed to stand overnight. Next morning 50 ml of 1 N acetic acid followed by 25 ml of 1 N calcium chloride was added and

the mixture was allowed to stand for 1 h, then it was boiled for 1-2 minutes and was filtered through previously weighed filter paper. The filter paper is then dried in oven at 100° C for 2h and is weighed and the total pectin as calcium pectate was calculated as below:

$$\text{Calculation: Pectin\%} = \frac{\text{weight of precipitate} \times 500 \times 100}{\text{ml of filtrate taken for estimation} \times \text{weight of sample}}$$

Protein content (%)

Protein content was determined by the micro kjeldhal method after digestion. This pulp nitrogen per cent was multiplied by the factor of 6.25 to get the percentage of protein in pulp.

Procedure

Take one gm pulp and add 10 ml sulphuric acid to it. Prepare catalyst mixture (5:1) of Copper sulphate and Potassium sulphate. Digest the sample at 250 °C initially and increases to 420 °C for 1-1.30 min by adding conc. sulphuric acid. For distillation take 4% Boric acid for each 50 ml conical flask and add 3 drops each Bromocresol green and Methyl red click power key and wait for steam, check all parameters by pressing reset. Add 40% NaOH 40 ml each sample and add manually to the digestion tube. Titrate the flash against 0.02 N H₂SO₄ till pink colour appears.

$$\text{Calculation: protein\%} = \text{Nitrogen\%} \times 6.25$$

Statistical analysis

The data obtained from the present investigation will be analysed as per the procedure suggested by Panse and Sukhatme, (1978)^[13].

Estimation of genetic variability parameters

i. Genotypic, phenotypic and environmental coefficient of variation

The genotypic (GCV), phenotypic (PCV) and environmental (ECV) coefficient of variation was calculated by the formulae given by Burton (1952)^[2].

ii. Heritability (h²)

Heritability percentage in broad sense is calculated by the formula as suggested by Johnson *et al.* (1955)^[10].

iii. Genetic Advance (GA)

Improvement in the mean genotypic value of selected plants over the parental population is called Genetic Advance. It is calculated by formula given by Johnson *et al.* (1955)^[10].

Results and Discussion

TSS (°Brix)

The total soluble solids (TSS) content among the 26 AKG genotypes and the control variety L-49 ranged from 9.28 °Brix (AKG-43) to 13.80 °Brix (AKG-42), with an overall mean of 10.89 °Brix. AKG-43 (9.28 °Brix) exhibited the highest TSS, which is followed by AKG-55 (12.40 °Brix) and AKG-56 (12.30 °Brix). Conversely, genotypes such as AKG-43 (9.28 °Brix) displayed the lowest TSS values. Lakade *et al.* (2011)^[11] identified Allahabad Safeda and L-49 as superior genotypes in terms of TSS and sugar content, indicating strong potential for selection.

The trait demonstrated moderate phenotypic (PCV = 11.01%) and genotypic (GCV = 10.79%) coefficients of

variation, reflecting moderate variability influenced by genetic factors. The low environmental coefficient of variation (ECV = 2.17%) further corroborates this, suggesting that environmental factors had a minimal impact on trait expression. A high broad-sense heritability (96.12%) was observed for TSS, along with a moderate genetic advance as a percentage of the mean (21.79%), indicating that selection for this trait could be both effective and stable across different environments.

Reducing sugars (%)

The content of reducing sugars among the guava genotypes assessed exhibited moderate variation, ranging from 3.97% in AKG-43 to 4.71% in both AKG-41 and L-49, with an overall mean of 4.41%. The genotype AKG-41 shows the highest reducing sugars content, which is followed by AKG-14 (4.69%), AKG-49 (4.68%) and AKG-33 (4.67%). While, AKG-5 displayed the lowest content at 3.96%. Meena *et al.* (2013) ^[12] reported notable variability in reducing sugars content among red-fleshed guava genotypes.

The genotypes that exhibited the highest levels of reducing sugars underscore the potential for selecting sweeter varieties based on this characteristic. Their research indicated that sugar accumulation varied significantly across genotypes, implying a robust genetic foundation for sweetness. Therefore, reducing sugars should be regarded as a crucial selection criterion in guava breeding initiatives. The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were recorded at 5.89% and 5.58%, respectively, suggesting minimal environmental impact, as evidenced by a low environmental coefficient of variation (ECV) of 1.87%. A high heritability estimate of 89.94%, along with a moderate genetic advance of 10.91%, indicates that the content of reducing sugars is predominantly influenced by additive gene action and can be effectively enhanced through selection. Similar conclusions were drawn by Meena *et al.* (2013) ^[12].

Total sugars (%)

The total sugar content among the 27 guava genotypes examined ranged from 7.79% (AKG-52) to 9.60% (AKG-49), with an overall mean of 8.64%. The genotype AKG-49 exhibited the highest total sugar content at 9.60%, which is at par with AKG-31 at 9.57% and AKG-41 at 9.53%. Conversely, the lowest sugar content was found in AKG-52 at 7.79%, indicating significant genotypic variation. According to Sanjana and Kavino (2024) ^[16], the half-sib guava progeny PG 1-7 demonstrated a notable total sugar content of 6.72%, along with elevated TSS and ascorbic acid levels. This suggests a strong potential for quality enhancement through the selection of total sugar content. The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were recorded at 6.40% and 6.16%, respectively, while the environmental coefficient of variation (ECV) was relatively low at 1.74%, indicating minimal environmental impact on trait expression. The heritability in the broad sense was exceptionally high at 92.57%, suggesting that the trait of reducing sugars is primarily influenced by genetic factors. Additionally, the genetic advance as a percentage of the mean was 12.20%, indicating a considerable opportunity for improvement through selection. These findings are consistent with those reported by Meena *et al.* (2013) ^[12] and Sanjana and Kavino (2024) ^[16].

Non reducing sugars (%)

The content of non-reducing sugars among the guava genotypes assessed varied from 3.26% to 4.92%, highest value recorded in AKG-49 at 4.92%, which is at par with AKG-31 at 4.88% and AKG-41 at 4.82%. Conversely, AKG-52 exhibited the lowest non-reducing sugars content at 3.26%. The overall mean for this characteristic was 4.24%, indicating a moderate level of accumulation across the genotypes. Meena *et al.* (2013) ^[12] also noted variations in non-reducing sugars among different genotypes. The genotype Lalit demonstrated significantly elevated levels, positioning it as a promising candidate for improved sweetness and fruit quality. The trait displayed a phenotypic coefficient of variation (PCV) of 9.67% and a genotypic coefficient of variation (GCV) of 9.38%, suggesting minimal environmental impact, as evidenced by an environmental coefficient of variation (ECV) of merely 2.35%. The broad-sense heritability was remarkably high at 94.10%, indicating robust genetic control. In parallel, the genetic advance as a percentage of the mean was 18.74%, implying considerable potential for enhancement through selection. These findings are consistent with previous research by Meena *et al.* (2013) ^[12].

Titrateable acidity (%)

The titrateable acidity (%) among the 26 AKG guava genotypes and the L-49 control exhibited significant variability, ranging from 0.41% (observed in AKG-7 and AKG-41) to 0.57% (noted in AKG-43). The lowest titrateable acidity was found in AKG-7, which is at par with AKG-1, AKG-25, AKG-44, AKG-47 and AKG-57. Conversely, the highest acidity was recorded in AKG-43 (0.57%). The overall mean titrateable acidity was 0.43%, indicating a moderate level of acidity across the genotypes. Similar range of variability in titrateable acidity among guava genotypes was documented by Gethe *et al.* (2025) ^[6], who identified genotypes with varying acid profiles that are suitable for quality enhancement through selective breeding. The trait demonstrated a phenotypic coefficient of variation (PCV) of 8.25% and a genotypic coefficient of variation (GCV) of 7.93%, indicating a relatively narrow gap between phenotypic and genotypic variability. This observation implies that the expression of titrateable acidity is predominantly influenced by genetic factors rather than environmental conditions. The environmental coefficient of variation (ECV) was recorded at 2.27%, further corroborating the minimal impact of environmental factors. Additionally, the heritability (broad sense) was calculated at 92.40%, suggesting a high potential for the genetic transmission of this trait to subsequent generations. The genetic advance as a percentage of the mean was 15.70%, indicating a strong selection efficiency for this trait.

Ascorbic acid(mg/100g)

The ascorbic acid levels among the 27 guava genotypes displayed significant genetic variability, ranging from 170.63 mg/100g in AKG-47 to 249.20 mg/100g in AKG-41, with an overall mean of 213.71 mg/100g. The highest ascorbic acid was found in AKG-41 (246.38 mg), which is at par with AKG-31 (246.10 mg), AKG-44 (246.38 mg) and AKG-9 (242.60 mg), indicating their superior vitamin C content. Conversely, lower levels of ascorbic acid were noted in genotypes such as AKG-5. A similar range of variability in ascorbic acid content was documented by

Shukla *et al.* (2012) ^[18], who emphasized significant differences among guava genotypes and identified high-vitamin C varieties that could enhance nutritional quality. The high phenotypic coefficient of variation (PCV) of 10.83% and genotypic coefficient of variation (GCV) of 10.65%, with a minimal difference between the two, suggest a low environmental impact and a strong genetic control over the trait. This assertion is further corroborated by an exceptionally high broad-sense heritability of 96.61%, which implies that selection based on phenotypic performance would be highly effective. Additionally, the genetic advance as a percentage of the mean (GAM) was recorded at 21.56%, indicating considerable potential for improvement through direct selection. These results align with the findings of Gupta and Kaur (2019) ^[8] and Sanjana and Kavino (2024) ^[16].

Pectin content (%)

The pectin content (%) across the assessed guava genotypes varied from 0.73% (AKG-52) to 0.98% (AKG-41 and AKG-49), with the highest values recorded in AKG-41 and AKG-49 (0.98%), which were statistically at par with AKG-9 (0.97%) and AKG-31 (0.96%). Conversely, the lowest values were noted in AKG-42 and AKG-51 at 0.74%. The overall grand mean was determined to be 0.87%, reflecting a moderate average pectin content among the genotypes. Lakade *et al.* (2011) ^[11] emphasized the significant variability in pulp-related characteristics among guava genotypes, which are closely linked to pectin concentration, thereby corroborating the differences observed.

A high degree of genetic variability was noted, with a phenotypic coefficient of variation (PCV) of 8.70% and a genotypic coefficient of variation (GCV) of 8.39%, alongside a very low environmental coefficient (ECV: 2.30%), indicating that environmental factors have minimal impact on this trait. The heritability in the broad sense was calculated at 93%, suggesting that pectin content is predominantly influenced by genetic factors and can be enhanced through selective breeding. The genetic advance as a percentage of the mean was 16.68%, indicating the potential for significant genetic improvement.

Protein content (%)

The protein content (%) among the assessed guava genotypes varied from 2.15% (AKG-40) to 2.51% (L-49) with the highest value recorded in L-49 (2.51%), which was statistically at par with (AKG-44) 2.50% and both AKG-31 and AKG-49 (2.47%). Conversely, AKG-40 (2.15%) exhibited the lowest protein content. The overall grand

mean was 2.34, indicating a moderate average pectin content across the genotypes. Ibrahim Imrana Farhan (2024) ^[9] investigated significant physiochemical and nutritional characteristics of fruit pulp from pink-fleshed common guava, which are closely linked to protein content, thereby corroborating the differences observed in the current study.

A high degree of genetic variability was noted, with a phenotypic coefficient of variation (PCV) of 5.03% and a genotypic coefficient of variation (GCV) of 4.42%, alongside a low environmental coefficient (ECV: 2.40%), suggesting that environmental factors have minimal influence on this trait. The heritability in the broad sense was calculated at 77.24%, indicating that protein content is predominantly controlled by genetic factors and can be enhanced through selective breeding. The genetic advance as a percentage of the mean was 8.00%, indicating the potential for effective genetic improvement.

Fruit weight (g)

The weight of fruit among the 27 guava genotypes varied from 135.78 g (AKG-43) to 287.62 g (AKG-44), with the maximum weight (287.62 g) being statistically at par with AKG-33 (241.00 g), AKG-49 (232.49 g) and AKG-52 (230.63 g). The overall mean fruit weight was 212.23 g, indicating moderate to high variability among the genotypes. These findings are consistent with those of Gethe *et al.* (2024) ^[7].

The genotypic coefficient of variation (GCV) was recorded at 12.70%, which is slightly lower than the phenotypic coefficient of variation (PCV) of 12.86%, suggesting a minimal impact of environmental factors. The environmental coefficient of variation (ECV) was 2.02%, further substantiating the genetic foundation of the observed variation. The heritability in the broad sense was found to be high (97.54%), indicating that fruit weight is largely governed by genetic factors and is suitable for selection. The anticipated genetic advance as a percentage of the mean was 25.84%, reinforcing the efficacy of direct selection for the enhancement of this trait, in agreement with the findings of Singh *et al.* (2015) ^[19].

Fruit length(cm)

In current investigation, the length of fruit among the 27 guava genotypes ranged from 5.70 cm (AKG-25) to 8.40 cm (AKG-44). The genotypes AKG-44 shows the maximum fruit length, which is followed by AKG-9 (8.28 cm), AKG-49 (7.90 cm) and AKG-51 (7.80 cm). The overall grand mean for fruit length was determined to be 7.09 cm. These results align with findings of Sanjana and Kavino (2024) ^[16].

Table 1: Mean Performance of Guava Based on Biochemical Traits

Genotypes	TSS °BRIX	Reducing Sugars%	Total Sugars%	Non-Reduce Sugars%	Titrateable Acidity%	Ascorbic Acid (mg/100g)	Pectin content%	Protein content%
AKG 1	9.90	4.24	8.36	4.12	0.42	207.37	0.85	2.37
AKG 4	10.20	4.42	8.42	4.00	0.44	211.13	0.89	2.23
AKG 7	11.40	4.65	8.75	4.20	0.41	228.37	0.92	2.20
AKG 9	10.30	4.70	9.37	4.66	0.44	242.60	0.97	2.31
AKG 14	12.80	4.69	9.23	4.54	0.41	240.21	0.94	2.36
AKG 15	10.70	4.15	8.01	3.86	0.43	206.91	0.84	2.30
AKG 19	9.50	4.15	7.97	3.82	0.44	202.01	0.88	2.41
AKG 25	9.90	4.60	8.80	4.20	0.42	224.12	0.94	2.38
AKG 27	10.13	4.58	8.60	4.02	0.43	206.42	0.93	2.16
AKG 31	12.20	4.69	9.57	4.88	0.43	246.10	0.96	2.47
AKG 32	10.10	4.23	8.13	3.90	0.47	193.32	0.80	2.43

AKG 33	10.30	4.67	9.12	4.45	0.44	232.14	0.94	2.29
AKG 37	10.10	4.28	8.25	3.97	0.45	198.00	0.84	2.34
AKG 40	11.90	4.05	7.99	3.94	0.44	206.03	0.86	2.15
AKG 41	10.90	4.71	9.53	4.82	0.41	249.20	0.98	2.49
AKG 42	13.80	4.31	8.73	4.42	0.43	184.72	0.74	2.37
AKG 43	9.28	3.97	7.96	3.97	0.57	192.28	0.81	2.35
AKG 44	11.90	4.50	8.86	4.36	0.42	246.38	0.87	2.50
AKG 45	9.80	4.00	8.43	4.43	0.52	210.02	0.80	2.45
AKG 47	9.30	4.30	8.48	4.18	0.42	170.63	0.82	2.17
AKG 49	12.10	4.68	9.60	4.92	0.47	203.54	0.98	2.47
AKG 51	11.60	4.13	8.14	4.01	0.45	217.31	0.74	2.39
AKG 52	10.30	4.63	7.79	3.26	0.46	243.60	0.73	2.25
AKG 54	10.40	4.51	8.73	4.22	0.45	206.31	0.91	2.29
AKG 55	12.40	4.45	9.17	4.72	0.42	189.60	0.89	2.34
AKG 56	12.30	4.16	8.97	4.81	0.48	175.36	0.88	2.23
L 49	10.60	4.71	8.50	3.79	0.45	209.16	0.94	2.51
Mean	10.89	4.41	8.64	4.24	0.44	213.71	0.87	2.34
SE(m) $\pm$	0.12	0.04	0.08	0.05	0.01	2.13	0.01	0.03
CD (5%)	0.33	0.12	0.21	0.14	0.01	5.98	0.03	0.08

Table 2: Mean Performance of Guava Based on Yield Contributing Characters

Genotypes	Fruit Weight (g)	Fruit Length (cm)	Fruit Breadth (cm)	Fruit Diameter (cm)	Fruit Volume (cc)	Pulp Weight (g)	Seed Weight (g)	Fruit Yield (kg/plant)
AKG 1	209.26	7.10	6.69	6.80	206.37	179.00	3.40	16.20
AKG 4	214.45	6.98	6.39	6.50	212.13	181.98	4.25	17.63
AKG 7	204.09	7.08	6.59	6.70	201.17	173.43	3.95	19.90
AKG 9	218.52	8.28	6.49	6.60	215.93	188.16	3.85	22.85
AKG 14	198.85	7.10	6.69	6.80	196.08	164.84	3.70	21.50
AKG 15	225.54	7.43	6.89	7.00	222.94	186.97	3.60	19.14
AKG 19	214.12	6.10	5.69	5.80	211.21	184.46	3.30	22.12
AKG 25	224.06	5.70	5.29	5.40	221.63	189.89	3.45	17.57
AKG 27	215.29	6.53	6.19	6.30	212.54	185.04	3.65	18.75
AKG 31	227.94	7.33	6.89	7.00	224.49	198.55	3.55	22.93
AKG 32	182.53	6.18	5.69	5.80	179.37	151.95	4.25	14.94
AKG 33	241.00	7.50	7.09	7.20	238.09	209.62	3.52	21.66
AKG 37	218.72	6.95	6.59	6.70	116.12	187.57	3.32	19.22
AKG 40	186.82	6.60	6.19	6.30	184.32	158.64	3.68	17.32
AKG 41	217.09	7.23	6.89	7.00	214.84	189.15	4.15	22.76
AKG 42	227.53	8.08	7.59	7.70	224.73	196.76	3.86	21.26
AKG 43	135.78	6.20	5.79	5.90	132.87	110.82	3.64	10.45
AKG 44	287.62	8.40	7.99	8.10	284.26	255.69	4.54	23.66
AKG 45	170.92	6.23	5.79	5.90	167.23	144.94	3.78	13.60
AKG 47	228.82	7.65	7.19	7.30	225.28	190.42	4.35	18.25
AKG 49	232.49	7.90	7.49	7.60	229.28	203.56	3.88	21.92
AKG 51	220.43	7.80	7.39	7.50	217.37	185.88	4.08	15.12
AKG 52	230.63	6.95	6.59	6.70	227.28	196.58	3.94	21.26
AKG 54	192.26	6.58	6.19	6.30	188.63	164.09	3.84	18.74
AKG 55	198.63	6.78	6.29	6.40	195.37	172.25	3.95	20.46
AKG 56	189.07	7.75	7.39	7.50	186.70	161.90	4.12	20.98
L 49	217.80	7.03	6.69	6.80	214.51	186.41	3.52	19.85
Mean	212.23	7.09	6.61	6.72	205.58	181.42	3.82	19.26
SE(m) $\pm$	2.14	0.21	0.07	0.07	2.16	1.97	0.04	0.21
CD (5%)	6.03	0.59	0.2	0.2	6.08	5.55	0.12	0.59

Table 3: Estimates of variability, heritability and expected genetic advance as percent over mean

Sr. No.	Character	PCV (%)	GCV (%)	ECV (%)	Heritability (%)	Expected Genetic Advance AS% of Mean
1.	Fruit weight (g)	12.86	12.70	2.02	97.54	25.84
2.	Fruit length (cm)	11.09	9.37	5.93	71.42	16.32
3.	Fruit breadth (cm)	10.08	9.85	2.12	95.57	19.83
4.	Fruit diameter (cm)	9.92	9.68	2.16	95.24	19.45
5.	Fruit volume (cc)	15.85	15.71	2.10	98.25	32.08
6.	Pulp weight (g)	14.12	13.95	2.17	97.63	28.40
7.	Seed weight (g)	10.02	9.77	2.20	95.17	19.64
8.	Fruit yield (kg/plant)	12.86	12.70	2.02	97.54	25.84
9.	TSS ° Brix	11.09	9.37	5.93	71.42	16.32
10.	Total sugars%	11.01	10.79	2.17	96.12	21.79

11.	Reducing sugars%	6.40	6.16	1.74	92.57	12.20
12.	Non reducing sugars%	5.89	5.58	1.87	89.94	10.91
13.	Titrateable Acidity%	9.67	9.38	2.35	94.10	18.74
14.	Ascorbic Acid (mg/100gpulp)	8.25	7.93	2.27	92.40	15.70
15.	Pectin content%	10.83	10.65	1.99	96.61	21.56
16.	Protein content%	8.70	8.39	2.30	93.03	16.68

Genetic analysis revealed phenotypic coefficient of variation (PCV) of 11.09% and genotypic coefficient of variation (GCV) of 9.37%, with minimal environmental impact (environmental coefficient of variation, ECV: 5.93%). The heritability estimate was 71.42%, and the genetic advance as a percentage of the mean was 16.32%, suggesting that fruit length is predominantly governed by genetic factors and can be effectively improved through selection. Comparable observations were made by Meena *et al.* (2013) [12].

Fruit breadth (cm)

The breadth of the fruit among the guava genotypes examined varied from 5.29 cm (AKG-25) to 7.99 cm (AKG-44). The genotypes AKG-44 shows the maximum fruit breadth, which is followed by (AKG-42) 7.59 cm, (AKG-49) 7.49 cm. The overall average fruit breadth was recorded at 6.61 cm. These findings are consistent with the research conducted by Sanjana and Kavino (2024) [16]. The analysis of genetic variability revealed phenotypic coefficient of variation (PCV) of 10.08% and genotypic coefficient of variation (GCV) of 9.85%, which suggests moderate level of variability with minimal environmental impact (environmental coefficient of variation, ECV: 2.12%). The heritability (broad sense) was notably high at 95.57%, and the genetic advance as percentage of the mean was 19.83%, indicating that fruit breadth is significantly governed by genetic factors and can be effectively improved through selection. These results align with the observations made by Singh *et al.* (2015) [19].

Fruit diameter

The diameter of fruit among the 27 guava genotypes varied from 5.40 cm (AKG-25) to 8.10 cm (AKG-44), with an overall mean of 6.72 cm. The maximum measurement was noted in AKG-44 (8.10 cm), which is followed by AKG-42 (7.70 cm) and AKG-49 (7.60 cm). Conversely, the smallest diameter was recorded in AKG-25 (5.40 cm) (Table 3.1). These findings are consistent with the research conducted by Sanjana and Kavino (2024) [16]. The evaluation of genetic parameters indicated a phenotypic coefficient of variation (PCV) of 9.92% and a genotypic coefficient of variation (GCV) of 9.68%, with an environmental coefficient of variation (ECV) of 2.16%, suggesting that environmental factors have a minimal impact on this trait. The heritability in the broad sense was found to be very high (95%), along with a genetic advance as a percentage of the mean (GAM) of 19.45%, indicating that fruit diameter is primarily influenced by additive gene action and can be improved through direct selection, similar observations were made by Singh *et al.* (2015) [19].

Fruit volume (cc)

In the current investigation, the volume of fruit among 27 guava genotypes varied from 116.12 cc (AKG-37) to 284.26 cc (AKG-44). The maximum measurement was noted in AKG-44 (284.26 cc), which is followed by AKG-33 (238.09 cc) and AKG-49 (229.28 cc) AKG (225.28 cc). The overall

grand mean for fruit volume was determined to be 205.58 cc. Gavhane *et al.* (2024) [5]. Genetic analysis indicated phenotypic coefficient of variation (PCV) of 15.85% and genotypic coefficient of variation (GCV) of 15.71%, signifying that the majority of the observed variability is genetically based. The environmental coefficient of variation (ECV) was relatively low at 2.10%, highlighting a minimal impact of environmental factors. The heritability (in the broad sense) was exceptionally high at 98.25%, and the genetic advance mean percentage was 32.08%, implying that selecting for increased fruit volume will be highly effective. These results align with earlier studies. Singh *et al.* (2015) [19].

Pulp weight (g)

The pulp weight across the 27 guava genotypes displayed notable variation, with values ranging from 110.82 g (AKG-43) to 255.69 g (AKG-44). The genotype AKG-44 recorded the highest pulp weight at 255.69 g, followed by AKG-33 (209.62 g) and AKG-49 (203.56 g). Conversely, the lowest pulp weight was found in AKG-43 at 110.82 g, indicating a significant genotypic diversity. The overall mean pulp weight was calculated to be 181.42 g. Singh *et al.* (2018) [20]. The phenotypic coefficient of variation (PCV) and the genotypic coefficient of variation (GCV) were recorded at 14.12% and 13.95%, respectively, indicating an environmental influence (ECV = 2.17%). The heritability in the broad sense was found to be very high at 97.63%, suggesting that the trait is largely governed by genetic factors. The anticipated genetic advance (at 5% selection intensity) was 28.40%, emphasizing the potential for effective selection and enhancement through breeding. As reported by Singh *et al.* (2018) [20].

Seed weight (g)

Seed weight among various guava genotypes ranged from 3.30 g (AKG-19) to 4.54 g (AKG-44), with an overall mean of 3.82 g. The genotype AKG-44 exhibited the highest seed weight at 4.54 g, closely followed by AKG-47, AKG-4, AKG-32 and AKG-41, all of which had weights of 4.15 g or more. In contrast, the lowest seed weights were recorded for AKG-19 (3.30 g). These results align with those reported by Singh *et al.* (2018) [20]. The trait demonstrated moderate genetic variability, characterized by a phenotypic coefficient of variation (PCV) of 8.72%, a genotypic coefficient of variation (GCV) of 8.40% and a very low environmental coefficient of variation (ECV) of 2.32%, suggesting minimal environmental impact. The heritability estimate was high at 92.94%, indicating robust genetic control, while the anticipated genetic advance was 16.69%, signifying significant potential for selection. These observations are consistent with those of Rajan *et al.* (2005) [14].

Fruit yield (Kg/Plant)

The fruit yield across the 27 guava genotypes displayed significant variability, with values ranging from 10.45 kg for AKG-43 to 23.66 kg/plant for AKG-44, which was

statistically the most superior. This was closely followed by AKG-31 at 22.93 kg, AKG-9 at 22.85 kg and AKG-41 at 22.76 kg. The lowest yield was noted in AKG-43 at 10.45 kg, while the overall grand mean yield stood at 19.26 kg/plant. Dubey *et al.* (2016). The high phenotypic coefficient of variation (PCV = 19.26%) and genotypic coefficient of variation (GCV = 16.47%) indicate a substantial inherent variability among the genotypes. The very low environmental coefficient of variation (ECV = 2.19%) suggests that environmental factors have a minimal impact on this trait. Heritability was found to be extremely high at 98.26%, indicating that a significant portion of the variation is genetically determined. The genetic advance as a percentage of the mean was also considerable at 33.64%, highlighting the potential for effective selection, by Gupta and Kour (2019)^[8].

Conclusion

The present investigation revealed that considerable genetic variability among the guava genotypes for fruit and biochemical quality traits, indicating the presence of substantial genetic potential for crop improvement. Among the fruit characters, AKG-44 was identified as the most promising genotype, recording superior performance for fruit breadth (7.99 cm), fruit volume (284.26 cc), pulp weight (255.69 g) and fruit weight (287.62 g), and also recorded the highest fruit yield (23.66 kg plant⁻¹). Simultaneously, AKG-33, AKG-49, AKG-31, AKG-9 and AKG-41 also showed superior performance for different fruit attributes and yield. The high heritability coupled with high genetic advance observed for fruit yield, fruit volume, pulp weight and fruit weight indicated a strong genetic contribution and suggested that these characters can be effectively improved through direct selection.

The highest genetic advance as per cent of mean was recorded for fruit yield (33.64%), followed by fruit volume (32.08%), pulp weight (28.40%) and fruit weight (25.84%), coupled with very high heritability, indicating substantial genetic control and a high expected response to selection. Accordingly, AKG-44, which exhibited superior performance for these major fruit and yield traits, may be considered a promising genotype for further evaluation.

Considerable variation was also observed for biochemical quality traits, providing opportunities for nutritional and quality improvement in guava. AKG-42 recorded the highest TSS (13.80 °Brix), indicating its potential for improving sweetness and table quality. AKG-41 was promising for reducing sugars (4.71%), ascorbic acid and pectin content, indicating its suitability for nutritional and quality improvement, while AKG-49 recorded the highest total sugars (9.60%) and non-reducing sugars (4.92%), making it a promising genotype for enhanced sweetness and fruit palatability. AKG-41 and AKG-49 also recorded the highest pectin content (0.98%), suggesting their potential for processing and value-added products. For protein content, L-49 recorded the highest value (2.51%), closely followed by AKG-44 (2.50%), indicating their usefulness for nutritional quality improvement.

Overall, the present research study identified superior genotypes represent valuable genetic resources like, AKG-44 may be useful as an promising elite genotype/parent particularly for improving fruit size, pulp weight, fruit volume and yield; AKG-42 for high TSS; AKG-41 for nutritional quality, reducing sugars and pectin; and AKG-49

for sugar profile, pectin and overall fruit quality. These promising genotypes should be further evaluated over multiple seasons and locations to confirm their stability, adaptability and consistency of performance under different environments. They may subsequently be utilized as elite planting material or parental lines in hybridization programmes aimed at developing high-yielding, large-fruited, high-pulp and nutritionally superior guava cultivars suitable for commercial cultivation and processing.

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