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RESEARCH PAPER

Selection of Promising Indigenous Guava Germplasm from Bauphal Upazila of Patuakhali District of Bangladesh

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ABSTRACT

A comprehensive evaluation of indigenous guava cultivars (*Psidium guajava* L.), including local accessions LAc-1, LAc-2, LAc-3, and LAc-4, was conducted to assess sensory, morphological, and biochemical attributes, aiming to identify promising genotype suitable for the Patuakhali district of Bangladesh. Utilizing sensory evaluations by an expert panel, the best local accession was chosen for a comparative analysis alongside two commercial check varieties, Kazi peyara (KAc) and Thai peyara (TAc), focusing on floral behavior, fruit characteristics, and sensory properties. Subsequently, the selected promising genotype underwent biochemical assessments at various maturity stages. The study was conducted in two main phases: the field study, which adhered to a Randomized Complete Block Design (RCBD), and the biochemical analyses (laboratory study), which followed a Completely Randomized Design (CRD). All the local accessions displayed noteworthy variations in their assessed quality attributes. Among the examined germplasms (LAc-1, LAc-2, LAc-3, and LAc-4), LAc-1 demonstrated the highest sensory scores of 8.07, 8.27, 8.73, 7.93, 7.87, 8.80 and 8.08 in pulp color, flavor, sweetness, fiberness, texture, crispiness, and overall acceptability, respectively. In the comparison of the indigenous accession LAc-1 with commercial varieties KAc and TAc, LAc-1 exhibited significantly higher flower production (72.25 m^{-2}), a shorter time to fruit setting (34.0 days), and a lower number of fruit drops (11.75 m^{-2}) compared to the other cultivars. Genotype LAc-1 produced significantly firmer fruit (2.73 N), fewer seeded fruits (263.50 per fruit), and the lowest seed weight (2.93 g per fruit). On the other hand, TAc exhibited the highest fruit weight (403.75 g), fruit length (9.75 cm), and fruit diameter (27.26 cm). The highest seed weight per fruit (6.08) was recorded in KAc. In terms of sensory evaluation, LAc-1 showed significantly higher scores of 8.16, 6.93, 8.10, 8.65, 6.81, 6.65, 8.60 and 7.58 in the surface color of ripe fruit, color, flavor, sweetness, fiberness, texture, crispiness, and overall acceptability respectively, compared to KAc and TAc. The biochemical properties of accession LAc-1 were investigated at various maturity stages, revealing that total soluble solids (10.36%) and total anthocyanin content (0.36 mg/100 g FW) were highest in maturity stage IV. In comparison of titratable acidity (0.19%), ascorbic acid (46.15 mg/100 g FW), and pH content (6.87) were highest in maturity stage I. Considering sensory attributes, floral behavior, and fruit characteristics, genotype LAc-1 emerged as the preferred choice, with maturity stage IV identified as the optimal harvest stage, given its elevated antioxidant content. The study results will provide valuable insights for farmers, researchers, consumers, and other stakeholders to maximize the potential of indigenous guava cultivars.

Key words: Guava cultivars; sensory properties, floral behavior, fruit characteristics, biochemical properties.

Introduction

Guava (*Psidium guajava* L.), a member of the Myrtaceae family, is a significant commercial fruit crop thriving in tropical and subtropical regions worldwide. Its adaptability extends to both cultivated and wild environments, and it is commercially cultivated in more than 60 countries. Hence, it is often referred to as the "apple of the topics" and has gained recognition as the "Poor man's apple" due to its widespread availability and affordability for everyone during the season (Hassan *et al.*, 2012, Nakasone and Paull, 1998). Renowned for being both nutritious and delicious, guava's refreshing taste and pleasant flavor make it a favorite among consumers. Notably, Bangladesh stands out as one of the world's significant guava producers, with a substantial cultivation area of 2,68,220 ha and a production output of 36,67,890 MT (BBS, 2021).

Due to its widespread popularity and associated health benefits, guava has emerged as a crucial and extensively consumed fruit in Bangladesh. Following mangoes, bananas, jackfruit, pineapples, and melons, it is regarded as the most valuable fruit in Bangladesh, considering both land area and yield. While guava is a common sight in every backyard garden, whether tended or neglected, commercial cultivation is primarily concentrated in the cities of Chittagong, Dhaka, Khulna, Rajshahi, Natore, Rangpur, Sylhet, and Barisal. The nutritional and health-promoting attributes of guava, along with its growing recognition for antioxidant properties, suggest its potential as a nutraceutical (Ho *et al.*, 2012). Labeled a "super fruit," guava is rich in B-group vitamins, vitamins C, A, and E, containing 3–6 times more vitamin A and C than oranges, 3 times more proteins and 4 times more fiber than pineapple, 2 times more lycopene than tomatoes, and slightly higher potassium than bananas (Moon *et al*., 2018; Reddy, 2017). An average guava fruit comprises 83% water, 15% carbohydrates, 2.58% protein, 2.8-5.5% crude fiber, 0.6% fat, and 0.7% ash, serving as a valuable source of micronutrients such as calcium (23 mg/100 g), phosphorus (42 mg/100 g), iron (0.09 mg/100 g), Vitamin C (250-300 mg/100 g), and Vitamin A (200-400 IU/100 g) (Kadam *et al*., 2012; Flores *et al*., 2015).

Guava is a highly heterozygous allogamous fruit crop. In Bangladesh guava has a wide range of variability (Chandra and Mishra, 2007). There are possibly 400 guava cultivars across the world, but among them, only a few are commonly cultivated across the universe (Pommer and Murakami, 2009). There is huge diversity in cultivated cultivars regarding tree appearance, bearing habit, fruit size, shape, nutrient composition, ripening season as well as yield (Sharma *et al*., 2010; Pommer and Murakami, 2009). Wide genetic variations of guava genotypes were observed in the Patuakhali district of Bangladesh. Irrespective of the morphological and biochemical variability detected in these cultivars, several reports designate the selection of genotype usually based on a few important traits (Mehmood *et al*., 2016; Valera-Montero *et al*., 2016; Mehmood *et al*., 2013) and, therefore, a huge variation of guava is left untouched.

Characterizing native genetic resources tailored to specific climatic conditions based on factors like flowering, fruit set, maturity, and quality is crucial for ensuring the economic viability of guava cultivation. Consequently, this investigation was carried out to explore the flowering patterns, fruit set, fruit maturation, nutritional quality and sensory evaluation of guava fruits, to identify promising genotypes suitable for Patuakhali district as well as coastal regions of Bangladesh.

Methodology

A comprehensive field study was conducted in four unions of the Bauphal upazila in Patuakhali district, Bangladesh, aimed to identify superior local guava germplasms. Chemical analyses were meticulously performed at the prestigious Post Harvest Laboratory, Department of Horticulture, Patuakhali Science and Technology University (PSTU). The study comprised two distinct phases: a field study, encompassing germplasm collection to evaluation, and a laboratory study focusing on assessing the biochemical properties of the selected superior germplasm at various ripening stages. The field experiment was conducted using a Randomized Complete Block Design (RCBD) with four replications, while the chemical analyses in the laboratory followed a Completely Randomized Design (CRD). Systematically, one branch was judiciously chosen in each cardinal direction (North, South, East, and West) to ensure comprehensive field data collection from each plant. Rigorous observations of flowering and fruiting behavior, alongside careful assessments of fruit quality parameters, were methodically documented.

From the total of 8 germplasms collected from Bauphal upazila, 4 local germplasm samples designated as local accession-1 (LAc-1), local accession-2 (LAc-2), local accession-3 (LAc-3), and local accession-4 (LAc-4) were specifically chosen for the further study (Fig.1).

LAc-1 (Avocado color and ovoid shape) LAc-2 (Bud green and round shape) LAc-3 (Pastel green and pear shape) LAc-4 (Olive drub and ellipsoid shape)

Figure 1. Selected local/indigenous germplasms (LAc-1, LAc-2, LAc-3 and LAc-4) from the study area and their color and shape.

Sensory attributes of guava fruit

From the chosen germplasms, an expert panel of 15 members identified one superior germplasm based on sensory characteristics such as the surface color of ripe fruit, as well as the color, flavor, sweetness, juiciness, fibreness, texture, crispiness and overall acceptability of the guava fruit pulp. The panel consisted of ten horticulturists (aged 25-50 years) and five post-graduate students. Before the evaluation, the panel underwent training using a pretest that involved assessing guava fruits with extremely dislike or like attributes on a hedonic scale ranging from 0 to 9 (Table 1). The panelists were instructed to score the samples based on the numbers (0 to 9) of the hedonic scale according to Wichchukit and Mahony (2014).

Table 1. The hedonic scale score used for the evaluation of guava germplasm

Description	Score
Like Extremely	9
Like Very Much	8
Like Moderately	7
Like Slightly	6
Neither Like nor Dislike	5
Dislike Slightly	4
Dislike Moderately	3

Dislike Very Much	2
Dislike Extremely	1

The superior germplasm selected was subsequently compared with the commercial guava varieties Kazi peyara (KAc) and Thai peyara (TAc) (Fig. 2). This comparison encompassed aspects of floral behavior (including the number of flowers and dropped fruits per meter square, as well as the flower-to-fruiting time), fruit characteristics (such as peel color, shape, firmness, individual fruit weight, length, diameter, number of seeds, and seed weight), and sensory attributes (covering surface color, flavor, sweetness, juiciness, fibreness, texture, crispness of the fruit pulp and overall acceptability).

LAc-1 (Avocado color and ovoid shape) KAc (Citron color and ovoid shape) TAc (Olive color and round shape)

Figure 2. Selected promising local germplasm (LAc-1) with Kazi peyara (KAc) and Thai peyara (TAc) and their color and shape.

Floral behavior of guava plant

The count of flowers per square meter involved placing a one-square-meter box in various sections of the tree canopy, followed by tallying the total number of flowers within the box. The assessment of dropped fruits per square meter was conducted by placing the box in different areas of the canopy after fruit development from flowers, and the count of dropped fruits was then recorded within the box. The duration from the initiation of flower development to fruit development determined the flower-to-fruiting time.

Fruit characteristics of guava

In this study, the peel color of multiple selected guava germplasms was determined using the On Color Measuring Software (Potato Tree Soft, version 3.0) with an aim point. The obtained data were integral to understanding and distinguishing the peel color variations, contributing valuable insights to the overall research on guava germplasm evaluation. Fruit shape was determined through visual observation and categorized as round, ovoid, ellipsoid, or pear-shaped. Fruit firmness was gauged using a fruit penetrometer (Model: GY-4) and expressed in Newton (N). The weight of guava fruit was measured with an electric balance (FA2004 2011111757) and expressed in grams (g). The length was determined by measuring from the basal to the polar ends using slide calipers and expressed in centimeters. The diameter was measured by determining the length from one side to the opposite side with slide calipers and expressed in centimeters. The number of seeds per fruit was ascertained by counting all seeds in a fruit, and seed weight was measured by weighing all seeds from a single fruit. To study the fruit characteristics a total of 60 (1 fruit × 4 branches × 15 plants) fully matured fruits were used in this study.

Subsequently, the best guava fruit variety underwent chemical analysis, including assessments of titratable acidity, total soluble solids, ascorbic acid content, pH, and anthocyanin content, at various ripening stages (Stage I, Stage II, Stage III, and Stage IV) of the fruit.

Biochemical properties of guava at different ripening stages

Chemical analyses of the promising guava genotype fruit pulp were meticulously conducted at distinct ripening stages, encompassing unripe (Stage I), semi-ripe (Stage II), moderately ripe (Stage III), and ripe (Stage IV) conditions (Fig. 3), showcasing a comprehensive examination of the fruit's biochemical evolution. The titratable acidity (TA) of guava fruit pulp was determined following the methodology by Ranganna (1977), while total soluble solids (TSS) were measured using a digital refractometer (BOECO, Germany). The ascorbic acid content in guava fruit pulp was determined via the dye method outlined by Ranganna (1977), and the pH of the pulp was measured using a glass electrode pH meter (GLP 21, Crison, Barcelona, EEC). The total anthocyanin content in the guava fruit peel was quantified according to the established method of Sims and Gamon (2002).

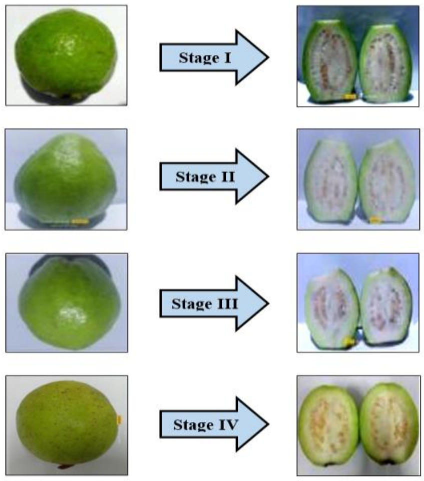

Figure 3. The outside view and transverse section view of LAc-1 at different maturity stages.

Statistical analysis

The data obtained in this study, encompassing diverse parameters, was systematically organized and tabulated to facilitate meticulous statistical analyses. The data collected for various parameters underwent rigorous statistical analysis using Minitab Statistical Software Version 17 (Minitab Inc., State College, PA, USA). Subsequently, means were differentiated by applying Tukey's HSD test at a significance level of 5% and 1% probability.

Results

Sensory properties of indigenous guava accessions

After the selection of local germplasms from the homestead area, they underwent a sensory evaluation test by a panel of experts. The data related to the sensory evaluation of the local guava germplasms are presented in Table 2. Sensory scores for various local guava accessions exhibited significant variation (P<0.05) in terms of surface color of ripe fruit, pulp color, flavor, sweetness, juiciness, fibreness, texture, crispiness, and overall acceptability ranging from 6.60 to 8.80, 6.07 to 8.07, 6.47 to 8.27, 7.07 to 8.73, 6.47 to 8.40, 5.93 to 7.93, 6.07 to 7.87, 6.80 to 8.80, and 6.68 to 8.08, respectively. Among the indigenous guava germplasms, LAc-1 exhibited the highest sensory scores in pulp color (8.07), flavor (8.27), sweetness (8.73), fibreness (7.93), texture (7.87), crispiness (8.80) and overall acceptability (8.08). Surface color of ripe fruit (8.80) and juiciness (8.40) scores were higher in accession LAc-4 and LAc-3, respectively. Conversely, LAc-3 recorded the lowest scores for the surface color of ripe fruit (6.60), pulp color (6.07), flavor (6.47), sweetness (7.07), fibreness (5.93), texture (6.07), and crispiness (6.80). The sensory score for juiciness (6.47) and overall acceptability (6.68) was the lowest in accession LAc-4.

Table 2: Sensory scores of selected local/indigenous guava accessions (LAc).

Acc. no.	Sensory score**								
		Pulp characteristics							
	Surface color of ripe fruit	Pulp color	Flavor	Sweetness	Juiciness	Fiberness	Texture	Crispiness	Overall acceptability
LAc-1	8.20^{ab}	8.07^{a}	8.27^{a}	8.73^{a}	6.73^{b}	7.93^{a}	7.87^{a}	8.80^{a}	8.08^{a}
LAc-2	7.33^{bc}	6.27^{b}	6.73^{b}	7.27^{b}	6.80^{b}	6.40^{b}	6.40^{b}	7.13^{bc}	7.24^{b}
LAc-3	6.60^{cd}	6.07^{b}	6.47^{c}	7.07^{b}	8.40^{a}	5.93^{c}	6.07^{b}	6.80^{c}	6.79^{b}
LAc-4	8.80^{a}	6.53^{b}	6.93^{b}	8.20^{ab}	6.47^{b}	6.20^{b}	6.60^{b}	8.20^{ab}	6.68^{b}
Level of significance	*	*	*	*	*	*	*	*	*
CV %	8.64	12.11	9.62	4.46	7.78	10.44	10.12	7.59	8.79

** Nine point hedonic scale; fifteen pre-trained experts were used for sensory Evaluation. Means in a column followed by the same letter (s) does not differ significantly from Tukey's HSD test. * Indicates significance at the 5% level of probability; CV=Coefficient of variation.

Floral behavior of guava plant

Number of flowers per meter square

There was a significant ($P<0.05$) variation in the number of flowers per square meter among different guava germplasms (Table 3). The number of flowers per square meter ranged from 31.0 to 72.25 across the guava germplasms. LAc-1 guava variety exhibited the highest number of flowers per square meter (72.25), followed by the KAc (34.75), while the TAc (31.0) recorded the lowest.

Flower to fruiting time

The time needed for flowers to transition into fruit exhibited a significant ($p<0.05$) variation among the various guava germplasms. The flowering to fruiting time ranged from 34.0 days to 39.75 days across different guava cultivars (Table 3). Among these germplasms, LAc-1 required the least time for fruiting (34.0 days), followed by TAc (37.75 days), and KAc had the longest time requirement (39.75 days).

Number of dropped fruit per meter saquare

There was a statistically significant variation ($p<0.05$) among the guava accessions concerning the number of dropped fruits per square meter (Table 3). The different guava cultivars exhibited a range in the number of fruit drops, from 11.75 to 19.75. TAc had the highest number of fruit drops (19.75), followed by KAc (14.75), and LAc-1 had the lowest number of fruit drops (11.75).

Table 3. Floral behavior of different guava germplasms.

Acc. name	No. of flower/square meter	Flower to fruiting time (days)	No. of dropped fruit/square meter
LAc-1	72.25^{a}	34.00^{c}	11.75^{c}
KAc	34.75^{b}	39.75^{a}	14.75^{b}
TAc	31.00^{c}	37.75^{b}	19.75^{a}
Level of significance	*	*	*
CV%	5.30	4.70	8.37

The means that a column followed by the same letter (s) does not differ significantly from Tukey's HSD test. * Indicates significance at the 5 % level of probability; CV=Coefficient of variation.

Fruit characteristics

Fruit Firmness (N): Significant variation ($p<0.05$) was observed among the different guava cultivars concerning fruit firmness. The fruit firmness of different guava germplasms ranged from 2.05 N to 2.73 N (Table 4). LAc-1 demonstrated the highest fruit firmness, scoring 2.73 N, followed by KAc (2.35 N) while TAc exhibits the softest texture with 2.05 N.

Weight of Fruit (g): There was a significant ($p<0.05$) variation in the weight of fruit among the different guava genotypes. The fruit weight of different guava germplasms ranged from 104.53 g to 403.75 g (Table 4). TAc leads in fruit weight with 403.75 g followed by KAc with 262.75 g, providing a substantial weight, and LAc-1 exhibits a lighter fruit with 104.53 g.

Length and diameter of fruit (cm): Length and diameter of the guava varied significantly ($p<0.05$) among the different cultivars (Table 4). TAc boasts the longest fruit with 9.75 cm, while KAc and LAc-1 follow with 8.60 cm and 7.28 cm, respectively. In terms of diameter, TAc leads with 27.26 cm, followed by KAc with 22.90 cm and LAc-1 with 17.05 cm.

Number of seeds per fruit and weight of seeds: The number of seeds per fruit and seed weight of the guava varied significantly ($p<0.05$) among the different cultivars (Table 4). KAc exhibits the highest number of seeds per fruit (423.75) and seed weight (6.08 g), providing a seed-rich experience. TAc follows with 357.50 seeds and 5.05 g weight, while LAc-1 has the fewest seeds (263.50) and lightest seeds (2.93 g).

Table 4. Fruit characteristics of selected three (3) guava accessions

Acc. name	Fruit firmness (N)	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)	No. of seeds /fruit	Weight of seed (g)
LAc-1	2.73[a]	104.53[c]	7.28[c]	17.05[c]	263.50[c]	2.93[c]
Kc	2.35[b]	262.75[b]	8.60[b]	22.90[b]	423.75[a]	6.08[a]
Tc	2.05[c]	403.75[a]	9.75[a]	27.26[a]	357.50[b]	5.05[b]
Level of significance	*	*	*	*	*	*
CV%	6.08	7.35	6.06	5.03	9.09	10.03

The means that a column followed by the same letter(s) does not differ significantly by Tukey's HSD test. * Indicates significance at the 5% level of probability; CV = Coefficient of variation

Sensory evaluation of guava cultivars

The sensory evaluation data for guava accessions (LAc-1, KAc, and TAc) is presented in Table 5. Sensory scores for different guava genotypes displayed significant variation ($p<0.05$) in surface color of ripe fruit, pulp color, flavor, sweetness, juiciness, fibreness, texture, and crispiness, ranging from 6.50 to 8.16, 6.48 to 6.93, 5.99 to 8.10, 6.34 to 8.65, 6.91 to 8.21, 6.04 to 6.81, 5.94 to 6.65, and 6.70 to 8.60, respectively. LAc-1 showed the highest sensory scores in surface color of ripe fruit (8.16), pulp color (6.93), flavor (8.10), sweetness (8.65), fibreness (6.81), texture (6.65), crispiness (8.60), and overall acceptability (7.58) compared to KAc and TAc. TAc accession scored the highest in juiciness of pulp (8.21). In contrast, TAc recorded the lowest scores for surface color of ripe fruit (6.64), flavor (5.99), sweetness (6.34), texture (5.94), crispiness (6.70) and overall acceptability (6.62). The lowest sensory score for juiciness (6.74) was observed in LAc-1, while KAc exhibited lower scores in pulp color (6.48) and fibreness (6.04).

Table 5. Sensory scores of guava genotypes

Acc. name	Sensory score**								
		Pulp characteristics							
	Surface color of ripe fruit	Color	Flavor	Sweetness	Juiciness	Fiberness	Texture	Crispiness	Overall acceptability
LAc-1	8.16[a]	6.93[a]	8.10[a]	8.65[a]	6.74[b]	6.81[a]	6.65[a]	8.60[a]	7.58[a]
KAc	6.50[b]	6.48[b]	6.26[b]	6.52[b]	6.91[b]	6.04[b]	6.29[ab]	8.10[a]	6.64[b]
TAc	6.64[b]	6.66[ab]	5.99[b]	6.34[b]	8.21[a]	6.46[ab]	5.94[b]	6.70[b]	6.62[b]
Level of significance	*	*	*	*	*	*	*	*	*
CV %	10.16	8.39	6.96	5.95	8.18	9.64	6.91	9.01	7.63

** Nine point hedonic scale; fifteen pre-trained experts were used for sensory Evaluation. Means in a column followed by the same letter (s) does not differ significantly from Tukey's HSD test. * Indicates significance at the 5% level of probability; CV=Coefficient of variation.

Biochemical properties of the selected Guava germplasm (LAc-1)

The study investigated flowering behavior and fruit characteristics, while the biochemical properties and nutritional quality of the fruit were specifically assessed for the best guava germplasm, local accession-1 (LAc-1).

Titratable acidity (TA) content (%)

Significant differences ($p<0.01$) were observed in the titratable acidity content among various ripening stages of guava (Fig. 4 A). Titratable acidity ranged from 0.07 to 0.19% at different ripening stages, with the highest acidity (0.19%) noted in ripening stage I, followed by stage II (0.17%). The lowest acidity (0.07%) was observed in ripening stage IV. Stage I exhibited 171.42% higher titratable acidity compared to stage IV, indicating that stage I is characterized by a higher overall acid content.

Total soluble solids (TSS) content (^{0}Brix)

TSS plays an important role in improving the quality of fruits and gives a rough idea of the sweetness. The presence of higher Total Soluble Solids (TSS) in guava indicates superior fruit quality. TSS exhibited significant variation ($p<0.01$) among different ripening stages of guava (Fig. 4 B). The content of total soluble solids in guava at various ripening stages ranged from 7.8 to 10.36. The maximum TSS percentage was recorded in ripening stage IV (10.36), followed by stage III (8.35), while the minimum percentage was observed in stage I (7.8) (Fig. 4 B). This suggests that stage IV displayed a 27.66 higher TSS than stage III.

Ascorbic acid content (mg/100gm FW)

A significant variation ($p<0.01$) was observed in ascorbic acid content across different ripening stages of guava (Fig. 4 C). The range of ascorbic acid content spanned from 41.94 to 46.15 mg/100g FW at various ripening stages. Ascorbic acid content was highest in ripening stage I (46.15 mg/100 g FW), followed by ripening stage II (44.45 mg/100 g FW), and with the lowest content observed in ripening stage IV (41.94 mg/100 g FW).

pH content

Significant variation ($p<0.01$) was observed in the pH levels among guava ripening stages (Fig. 4 D). The pH content of guava fruit at different ripening stages ranged from 4.31 to 6.87. It was found that the fruit pH was higher in ripening stage I (6.87) followed by stage II (6.25), whereas the lowest pH content was recorded in stage IV (4.31).

Total anthocyanin content (mg/100gm FW)

Anthocyanins, a group of phenolic compounds in the plant kingdom, exhibit significant antioxidant properties. The data revealed a notable variation (p<0.01) in anthocyanin content across different ripening stages of guava (Fig. 4 E). Anthocyanin content ranged from 0.25 to 0.36 mg/100g at various ripening stages. Stage IV exhibited the highest anthocyanin content (0.36 mg/100g FW), followed by stage III (0.32 mg/100g FW), and while the lowest content was observed in stage I (0.25 mg/100g FW).

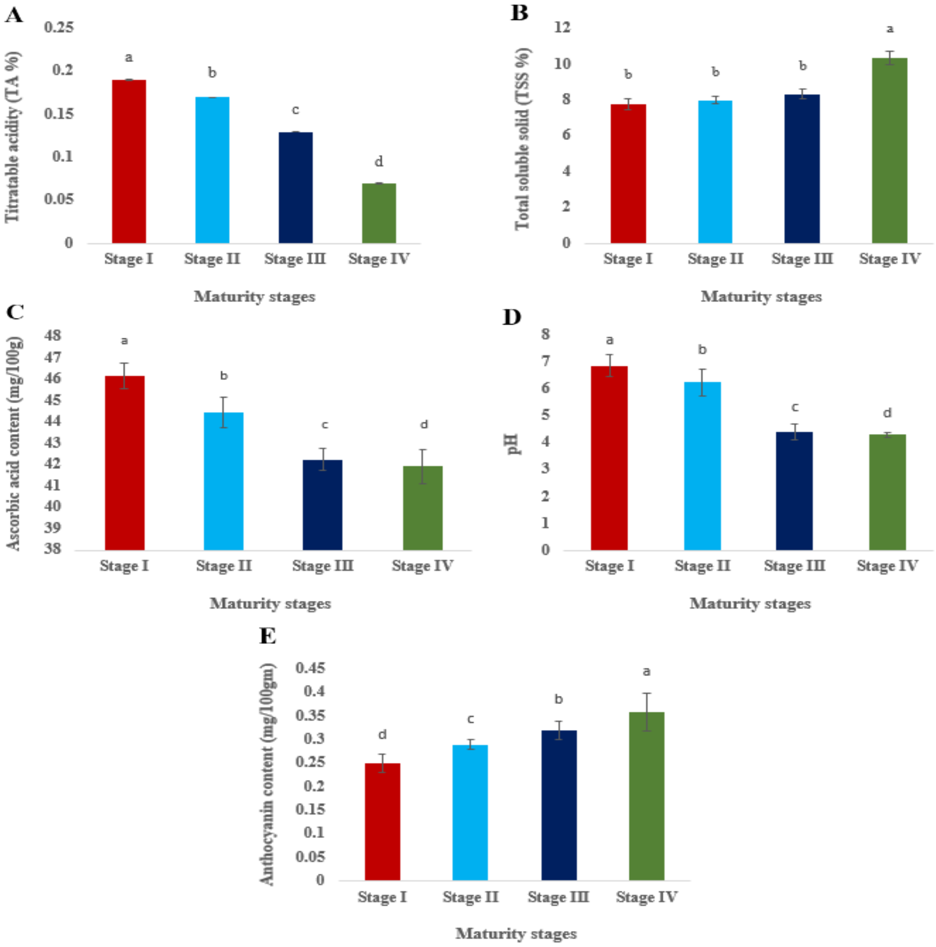

Figure 4. Titratable acidity **(A)**, Total soluble solids (B), Ascorbic acid **(C)**, pH **(D)** and Anthocyanin **(E)** content of guava at different ripening stages. Vertical bars represent the standard error of the mean.

Discussion

Sensory properties of indigenous guava accessions

Significant variation was observed concerning the surface color of the ripe guava fruit among different accessions. The values recorded in this study ranged from 6.60 to 8.80. The findings are in agreement with the findings of Yousafi *et al*. (2021) who reported the color value of guava ranged from 3.8 to 8.0 in different genotypes. The pulp color of guava ranged from 6.07 to 8.07 in different guava accessions in this study. Values recorded in this work regarding flavor are more or less similar to those reported by Yousafi *et al*. (2021) in different guava cultivars as 6.47–8.27, respectively. In our findings, we observed that flavor value raged from 6.47 to 8.27 among different guava accessions. Among the different guava accessions, it was observed that the sweetness value varied from 7.07 to 8.73 while the juiciness value ranged from 6.47 to 8.40 and in case of fiberness, it was 5.93 to 7.93. Significant variation was observed in texture of guava accessions which varied from 6.07 to 7.87. Yousafi *et al*. (2021) reported that texture values ranged from 5.2 to 8.0 among different guava cultivars. The findings conform to our findings about the texture value of different accessions. The consumer perceives color as the most crucial sensory attribute, as emphasized by Bashir and Abu-Goukh (2003). Texture (Waldron *et al*., 2003), flavor (Soares *et al*., 2007) and sweetness scores (Yousafi *et al*., 2021) are important quality attributes of fruits. Crispiness is the "one sound event perceived as a sharp, clean, fast, high pitched sound and evaluated with the incisors and lips open" and is generally varied with cultivars (Chauvin *et al*., 2008). Among the examined guava accessions, LAc-1 was deemed the most acceptable. The results indicate that among the studied indigenous guava accessions, LAc-1 consistently exhibited higher sensory scores across various attributes, suggesting its superior quality in terms of surface and pulp color, flavor, sweetness, fiberness, texture, crispiness and overall acceptability.

Floral behavior of guava cultivars

Understanding the flowering and fruiting behavior of fruit trees is essential for both fruit growers and breeders. The number of flowers per meter square varied from one genotype to another genotype. Local accession LAc-1 produced a significantly higher number of flowers per meter square which was 107% higher than that of the

KAc accession and 133% higher than that of the TAc accession. This might be due to the differences among the cultivars. Present findings are supported by Shukla *et al*. (2022), who reported that flowering percentage varied from genotype to genotype in guava. The variations among cultivars with regard to physical characteristics could be due to genetic variability and climatic adaptability in a particular region, which might prove to be an important diagnostic character for the selection of germplasm for local conditions (Shukla *et al*., 2022 and Dolkar *et al*., 2014). Flowering to fruit setting time is an important characteristic of a quality cultivar. Flowering to fruit setting time varied significantly with the different accessions. It was observed from the data that accession LAc-1 set fruit 3.75 days earlier than that of accession TAc and 5.75 days earlier than that of KAc. Our findings are in agreement with the findings of Sahoo *et al*. (2017) reported flowering of guava varies from 44 to 52 days. The highest number of fruit drops was observed in TAc followed by KAc and the lowest number of fruit drops was recorded in LAc-1. Accession LAc-1 exhibited a 26% and 68% less fruit drop than KAc and TAc respectively. The previous research conducted by Dolkar *et al*. (2014) reported that the percent fruit drop varied with cultivars. Sahoo *et al*. (2017) reported a fruit drop of 30.0 to 60.33% in guava while evaluating different guava genotypes. The findings indicate the superiority of accession LAc-1 concerning higher flowering rate, early fruit set and less fruit drop.

Fruit characteristics

Firmness is a key factor in accessing fruit quality. Significant variation was observed in fruit firmness among different cultivars. Accession LAc-1 exhibited 16% and 33% more farmer fruit than KAc and TAc respectively means that KAc and TAc have soft pulp and LAc-1 has quite harder pulp. This type of variation might be due to the variations among the genotypes. A similar variation in fruit firmness among different accessions was also reported by Rajan *et al*. (2012) in guava. Fruit weight among different cultivars varied significantly. The bigger size fruit was produced by TAc (403.75 g) followed by KAc (262.75 g) and the smaller fruit was observed in LAc-1 (104.53 g). This information indicates that TAc was 54% and 286% higher in weight than that of KAc and LAc-1 respectively. Values observed in this study were relatively similar to previous reports of Kumari *et al*. (2020), Biswas (1999) and Ram *et al*. (1997) as 74.88-353.75 g, 310 g and 75–300 g, respectively, in different guava cultivars. The genetic makeup of a cultivar is responsible for the observed differences in fruit length (Kaur *et al*., 2011). The fruit length observed in this study varied from 7.28 to 9.75 cm. The values recorded in this work were higher than those reported by Khan *et al*. (2023) and Methela *et al*. (2019). Their value ranged between 5.36 cm (Kazi peyara) to 6.96 cm (Thai peyara) and 4.43 cm (Sayedi peyara) to 9.38 cm (Chiangmai peyara), respectively. The size of a fruit is an inherent characteristic determined by the variety, and it can be affected by environmental factors, seasons and geographic locations (Kumari *et al*., 2020). The findings of this study align with earlier studies by Pandey *et al*. (2007) and Patel *et al*. (2007), where they documented variations in fruit length ranging from 5.8 to 7.2 cm and 5.1 to 7.0 cm, respectively, across diverse guava cultivars. Fruit diameter varied significantly and ranged from 17.5 cm to 27.26 cm. The values obtained in this experiment are relatively higher than those reported by Methela *et al*. (2019) and Mahour *et al*. (2012). Methela *et al*. (2019) reported a fruit diameter of 4.27 cm to 8.8 cm in different guava cultivars. Gohil *et al*. (2006) and Singh *et al*. (2008) have previously reported varietal differences in physical characteristics. The observed diversity in fruit diameter could be linked to interactions involving both phenotypic and genotypic factors within the cultivar (Ali *et al*., 2014). This information indicates that TAc was the larger guava cultivar than that of KAc and LAc-1. The number of seeds per fruit in this study varied from 263.50 to 423.75 among different accessions and there was a significant variation. The values obtained in this study are relatively higher than those reported by Methela *et al*. (2019), who reported that the number of seeds per fruit ranged from 196.4 to 352.8. among different cultivars. Our findings conform with the findings of Kumari *et al*. (2020), who reported number of seeds per fruit ranged from 36 to 439. The hereditary structure of the plant governs the number of seeds per fruit. Previous studies by Nag (1998) have also documented variations in seed count among different guava germplasms. Significant variation was observed in seed weight among guava cultivars and the values ranged from 2.93 to 5.05 g. The values observed in this study are relatively close to those reported by Methela *et al*. (2019), who observed that the weight of seed per fruit ranged from 1.94 g to 4.39 g. In a previous study, Ullah *et al*. (1992) noted a range of 1.9 g to 7.5 g for the seed weight per fruit, a value considerably higher than that observed in the current study. This data informs consumers about seed-related attributes, influencing their preferences. The superior flowering and fruiting characteristics of guava germplasm LAc-1, marked by increased floral abundance, accelerated flowering, minimal dropped fruits, enhanced fruit firmness, reduced seed count per fruit, and lighter seeds, underscore its potential as a distinguished choice for cultivation, providing valuable implications for selection strategies and horticultural practices.

Sensory properties of guava cultivars

The surface color of the guava fruit among different cultivars namely local accession-1 (LAc-1), Thai peyara (TAc) and Kazi peyara (KAc) ranged from 6.50 to 8.18. The values recorded in this study were closely related to the findings of Yousafi *et al*. (2021) reported color value of guava cultivars varied from 3.8 to 8.0. In this study, the color value of pulp among different guava cultivars ranged from 6.48 to 6.93 and in case of flavor, it was 5.99 to 8.10. Similar findings were also reported by Yousafi *et al*. (2021) in guava (4.6 to 8.0) which support the present study. Sweetness, juiciness and fiberness values of the guava cultivars in this study varied from 6.34 to 8.65, 6.74 to 8.21 and 6.04 to 6.81, respectively. The texture score of guava genotype ranged from 5.94 to 6.65. Yousafi *et al*. (2021) reported the texture value of guava cultivars from 5.2 to 8.0, which supports the present study. The crispiness value of guava accessions ranged from 6.70 to 8.60 in this study. LAc-1 stood out as the most acceptable guava accession among the selections under investigation. The superior sensory performance of LAc-1 across various attributes, including surface and pulp color, flavor, sweetness, fiberness, texture and crispiness underscores its potential as a high-quality guava accession, providing valuable insights for breeding and cultivation strategies

Biochemical properties of guava genotype at different maturity stages

In this study selected superior local accession LAc-1 was subjected to biochemical analysis at different ripening stages. The presented data on different ripening stages of guava (Stage I, Stage II, Stage III, and Stage IV) provides valuable insights into the quality attributes of the fruit, considering titratable acidity, Total Soluble Solids (TSS), ascorbic acid content, pH, and anthocyanin content. The results showed that all the biochemical parameters were significantly varied with each other and the titratable acidity and ascorbic acid content were higher in stage I whereas pH, TSS and anthocyanin content were higher in stage IV. The declining trend in titratable acidity from Stage I to Stage IV (0.19 to 0.07%) suggests a decrease in the overall acidity as the guava ripens. This shift is consistent with the typical maturation process of fruits where acidity diminishes, contributing to a milder taste. Titratable acidity is the indicator of the acidity of fruits and is directly related to the amount of organic acid present. Due to the metabolic changes and usage of organic acids during the respiratory process acidity may be reduced during maturity Maftoonazad *et al*. (2008). The lowest acidity in Stage IV indicates a potentially sweeter taste compared to earlier stages. The progressive increase in TSS from Stage I to Stage IV (7.8 to 10.36) indicates a rise in sugar concentration during ripening. TSS increased in guava due to the decrease in organic acid decline with the advancement of maturity where organic acids are used in the respiration process resulting in increased sugar content and higher pH (Bashir *et al*., 2003; Hegde and Chharia 2004; Kafkas *et al*., 2007). The rise in sugar content as the fruit matures and ripens could be attributed to the depolymerization of polysaccharides and the conversion of fruit starch into sugars. Our findings are in accordance with the findings obtained by Singh and Jain (2007). Stage IV, with the highest TSS, is expected to offer a sweeter and more flavorful taste compared to the earlier stages, aligning with consumer preferences for ripe and sweet guavas. The fluctuation in ascorbic acid content across ripening stages (41.94 to 46.15 mg/100g FW) reveals a potential influence of ripening on the fruit's vitamin C levels. Stage I has higher ascorbic acid content than that of the others and the lower ascorbic acid content was observed in stage IV. This indicates a decreasing trend in ascorbic acid content as the guava ripens. Our results are in accordance with the findings of Gull *et al*., 2012; Lim *et al*., 2006 and Gomez and Lajolo 2008, who reported an increase in ascorbic acid content with the progression of maturity. The increase in ascorbic acid contents of guava might have been due to the breakdown of starch to glucose which increases the biosynthesis of ascorbic acid during maturation (Lim *et al*., 2006). Notably, stage I exhibited a 10.04% higher total ascorbic acid content compared to stage IV, emphasizing the importance of stage IV in terms of elevated antioxidant properties. The increasing trend in pH from Stage I to Stage IV (4.31 to 6.87) indicates a decrease in acidity as the guava ripens. It was observed that stage I showed 59.40% higher pH content than that of stage IV, meaning that stage I is less acidic, while stage IV is more acidic. This positively correlates with titratable acidity and ascorbic acid content. In a previous research, Farah *et al*. (2020) reported the stability of ascorbic acid at a lower pH (3.4) and a decline in a higher pH (8.1). Ionization takes place under acidic conditions, maintaining the effectiveness of ascorbic acid at a pH of 4.0 (Muhammad *et al*., 2015). Conversely, under alkaline conditions, vitamin C undergoes proton donation, leading to significant alterations in its structure (Morteza and Sedigheh, 2016). Anthocyanins, found within the plant kingdom, are a category of phenolic compounds known for their notable antioxidant properties (Ajila *et al*., 2007). The ascending trend in anthocyanin content from Stage I to Stage IV (0.25 to 0.36 mg/100g FW) suggests an increase in antioxidant compounds as the guava matures. Notably, stage IV demonstrated a 44% higher total anthocyanin content compared to stage I, emphasizing its significance for enhanced antioxidant properties. Stage IV, with the highest anthocyanin content, indicates a potential health benefit associated with consuming fully ripe guavas.

Conclusion

The increasing consumer preference for fruits with distinct health advantages underscores the need for developing new varieties, emphasizing the essential role of characterizing available genetic resources. In this study, diverse guava cultivars exhibited notable variations in sensory characteristics, floral behavior, and fruit attributes. Among these, the indigenous guava accession LAc-1 emerged as the most promising, with maturity stage IV identified as optimal for harvesting based on biochemical properties. The selection of this genotype holds significant potential for future guava improvement initiatives. The research outcomes are anticipated to serve as a foundational reference for farmers, researchers, scientists, technologists, exporters, and other stakeholders, facilitating the realization of the inherent potential in indigenous guava cultivars. The authors recommend ongoing efforts in guava germplasm collection to uncover additional variability in desired traits, urging the repetition of such studies for comprehensive insights.

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