Journal of Environmental Sciences and Sustainability
ISSN: 3106-7883 | 3106-7875
Volume 2, Issue 4, 2025

VARIATION IN MORPHOLOGICAL AND BIOCHEMICAL PARAMETERS AMONG THREE CULTIVARS OF MANGO (*MANGIFERA INDICA* L.)

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Keywords
Mangifera indica, mango varieties, Sindhri, Langra, Kingstone Pride, morpho-biochemical characterization, breeding, fruit quality.

Article History
Received: 10 October 2025
Accepted: 15 December 2025
Published: 31 December 2025

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Abstract

Mango (Mangifera indica L.), widely known as the "King of Fruits," is prized for its unique aroma, rich flavor, and high nutritional value, underscoring its economic and dietary significance. Accurate characterization of mango varieties is crucial for effective genetic improvement and breeding programs.

This study, conducted at the Horticultural Research Station in Bahawalpur, evaluated and characterized three mango cultivars–Sindhri, Langra, and Kingstone Pride–using an integrated morpho-biochemical approach. Morphological parameters, including fruit length, width, peel weight, pulp weight, stone weight, and total fruit weight, were measured alongside biochemical attributes such as total soluble solids (TSS), titratable acidity (TA), ascorbic acid content, total phenolic content, anthocyanins, carotenoids, and the activities of antioxidant enzymes (peroxidase [POD] and catalase [CAT]).

The results revealed considerable variation among the cultivars. Langra demonstrated superior morphological performance, Sindhri excelled in fruit quality characteristics, and Kingstone Pride exhibited the greatest antioxidative capacity. These findings highlight significant genotypic diversity in both morphological and biochemical traits, providing a valuable basis for future mango breeding and cultivar improvement efforts.

INTRODUCTION

Mango (Mangifera indica L.) is a vital fruit crop and known as the King of fruits owing to its unique aroma, taste and high nutritional value (Lebaka et al., 2021). Mango is cultivated worldwide, with significant production in Asian countries such as India and Pakistan etc. where almost 1000 varieties are grown (Singh, 2016). Mango fruit displays significant variation in physical and sensory traits, including size, shape, color, and flavor (Siddiqui et al., 2015). The wood obtained from the mango tree is widely utilized for budget-friendly furniture, ceiling panels, window frames, sturdy packing crates, matchsticks, brush handles, oar blades, farming tools, and more (Krishna and Singh, 2007). All parts of the plant are useful in treating a range of ailments, such as abscesses, fractured horns, bites from rabid animals (like dogs or jackals), tumors, snakebites, stings, and poisoning caused by Datura ingestion. They are also applied for managing heat stroke, miscarriage, anthrax, blisters, oral wounds, ear inflammation, colic, diarrhea, tongue inflammation, indigestion, bacterial infections, bloody dysentery, liver issues, frequent urination, tetanus, and asthma (Gálvez-López et al., 2010).

Worldwide, over 1,000 identified mango cultivars are generally classified into two main groups: Indochinese and West Indian (Igbari et al., 2019). The Indochinese group typically features flattened, kidney-shaped, slightly elongated fruits with light green or yellow skin and minimal to no red blush. In contrast, West Indian cultivars are generally rounder and plumper, often displaying a vibrant red blush. It's important to note that many cultivars result from selective breeding and genetic improvement efforts (Bompard, 1992) Describing mango varieties is essential for mango improvement and breeding. Breeding programs that utilize germplasm with unique traits require detailed information to develop new cultivars effectively (Shahid et al., 2024). Various approaches and techniques for documenting and thoroughly reporting mango genotypes–based on structural, biochemical, agronomic, and genetic characteristics have been published (Khan et al., 2015; Shahid et al., 2024).

To our best knowledge the characterization of mango varieties from Southern Punjab region is limited. To address the need for detailed characterization of mango varieties, this study evaluates three prominent cultivars—Sindhri, Langra, and Kingstone Pride—grown in South Punjab, using a morpho-biochemical approach.

MATERIALS AND METHODS

This study was carried out at the Horticultural Research Station in Bahawalpur, utilizing three mango varieties—Sindhri, Kingstone Pride, and Langra. Fresh fruit samples of uniform size and quality (20 fruits) were collected from the experimental mango orchard at the Mango Research Centre, Shujabad. The samples were stored at room temperature to allow for natural ripening. After one week, when full color development was observed, fruit length, width, and weight were measured using a vernier caliper. Each fruit was then separated into three components: pulp, peel, and stone, and their weights were determined using a weight balance.

Total Soluble Solids, Titrateable Acidity and Ascorbic Acid Content TSS were assessed using a refractometer, TA was determined by acid-base titration, and ascorbic acid content was analyzed using a 1,10-phenanthroline spectrophotometer (Chen et al., 2020).

Total Phenolic Content

A 100 mL volume of plant extract was combined with 0.75 mL of Folin–Ciocalteu reagent and incubated at 22°C for 5 minutes. Next, 0.75 mL of Na_2CO_3 solution was added, and the mixture was maintained at 22°C for 90 minutes. The sample's absorbance was subsequently measured at 725 nm using a spectrophotometer (Shahbaz et al., 2023). Anthocyanin and Carotenoids Content For assessing the levels of carotenoids and anthocyanins, a gram of the sample was extracted with a 15:85 HCl-methanol solution, subjected to a shaking water bath at 25 °C for six hours. Following this, the sample was centrifuged for 20 minutes at 4 °C at 4000 × g using a temperature-controlled centrifuge. The absorbance of anthocyanins was measured at wavelengths of 650, 620, and 530 nm employing a UV–Vis spectrophotometer (2326 K, Hermle Labortechnik GmbH, Wehingen, Germany). The total anthocyanin content (mg Kg−1 FW) was calculated using the equation:

Anthocyanins = (A530 nm − A620 nm) − 0.1 (A650 nm − A620 nm The pigments involved in photosynthesis were quantified through spectrophotometry. A small amount of acid-washed sand was mixed with 5 ml of acetone to create a homogeneous pulp sample (0.1 g) (BDH Chemicals, England). Afterward, the mixture was filtered through Whatman No. 1 filter paper and centrifuged at 9,000 rpm for three minutes at room temperature. Absorbance of the resulting filtrate was then measured at 470, 645, and 662 nm. The pigment concentration, expressed in µg per gram of fresh weight (FW), was calculated using the following formula

Cx + c = (1000A470 - 1.90Ca - 63.14Cb) / 214 A470 refers to the absorbance at 470 nm (the wavelength designated for carotenoids), while Ca denotes chlorophyll a, and Cb signifies chlorophyll b. Cx + c represents the total carotenoid concentration assessed in terms of xanthophylls and carotenes.

Antioxidative Enzymes Activity

For estimation of peroxidase activity, reaction mixture consisted of 2 mL, containing 200 µL of H_2O_2 (27.5 mM), 200 µL of enzyme extract, and 1 mL of water. Absorbance was measured at 470 nm using a spectrophotometer, and the reaction mixture was exposed to fluorescent light for 7 minutes (Shahbaz et al., 2023).

Catalase (CAT) activity was measured following the method described by Liu et al. (2013). A 1000 µL volume of fruit extract was mixed with 1000 µL of freshly prepared H_2O_2 solution (5.9 mM), and absorbance was recorded at 240 nm.

Statistical Analysis

This study was carried out under complete randomized design (CRD). Data were analyzed using one-way ANOVA with means compared through LSD test ($p < 0.05$) using Statistics 8.1

RESULTS

Fruit Length and Width

Facts associated with fruit length and width are accessible in Figures 1a and 1b expose that Langra has significantly maximum length and width (15.8 cm and 9.84 cm) as compared to the other 2 varieties.

Journal of Agricultural Innovation and Sustainability
ISSN: 3106-7921 | 3106-7913
Volume 2, Issue 3, 2025

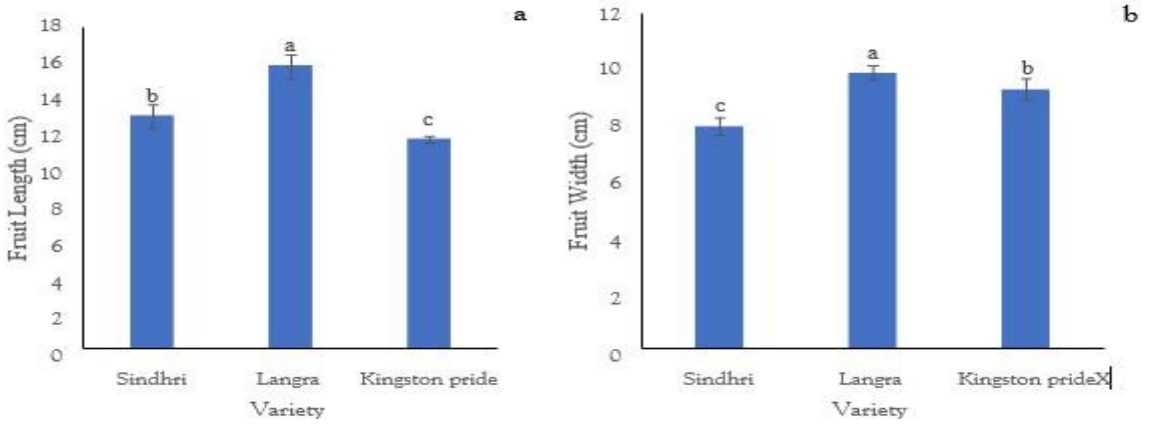

Figure 1. shows Fruit Length (1a) and Fruit width (1b) of 3 mango varieties. Data compiled from the average of three replicates, with vertical bars indicating the standard deviation of the means. Mean values having different superscript letters differs significantly (P < 0.05)

Fruit, Stone, Pulp and Peel weight

The average fruit weight ranged from 646g to 410g. The highest fruit weight was noted in Langra when compared to Sindhri and Kingstone Pride, while Sindhri had the lowest weight, as illustrated in Figure 2a. Pulp weight exhibited significant variation among the different varieties. Sindhri had the lowest pulp weight at 262.58g, whereas Langra recorded the highest at 426g (see Figure 2b). According to Figures2c and 2d, Langra also had the greatest peel and stone weights, measuring 73.8g and 57.4g, respectively. No significant difference was noted among Langra and Kingstone pride in case of Ascorbic acid content while sindhri depicted low ascorbic acid content (844 mg/100g) (Figure 3c).

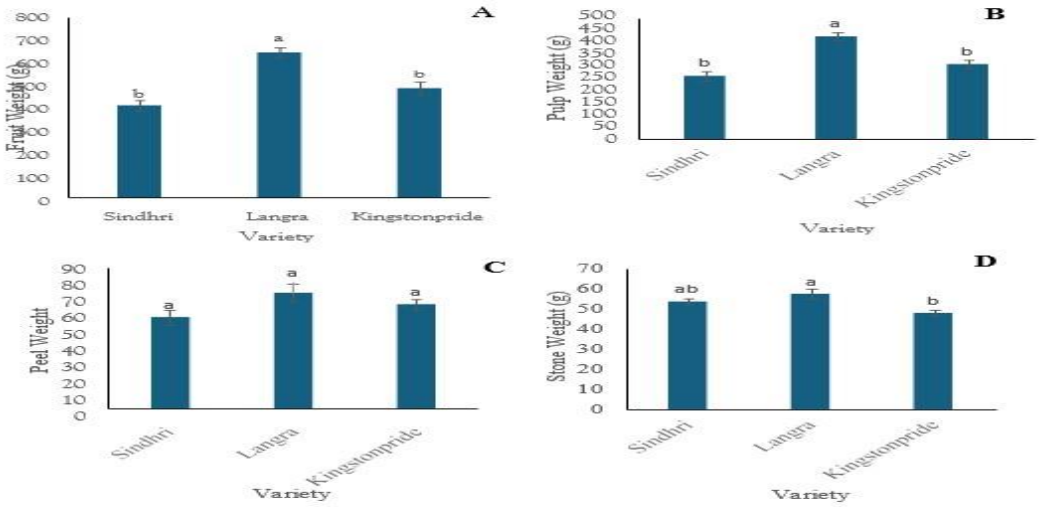

Figure 2. Fruit weight (A), Pulp weight (B), Peel weight (C), Stone weight (D) of 3 Mango varieties. Data compiled from the average of three replicates, with vertical bars indicating the standard deviation of the means. Mean values having different superscript letters differ significantly (P < 0.05).

Journal of Agricultural Innovation and Sustainability
ISSN: 3106-7921 | 3106-7913
Volume 2, Issue 3, 2025

Total Phenolic Content

Langra has maximum value (44 mg GAE/g DW) of total phenolic content as compare to other 2 varieties while no significant variations were found among the phenolic contents of Sindhri and Kingstone pride (Figure 4) and Langra showed maximum phenolic compounds as compared to the other two mango varieties.

Anthocyanin and Carotenoid Content

Carotenoid and Anthocyanin content were calculated through 3 Wavelengths i.e. 662, 645, 470 and 530, 620 and 650 respectively. For the estimation of carotenoid content, when subjected to wavelengths of 470, 645 and 662, Kingstone pride has maximum value as compare to other 2 varieties (Figure 5a, b and c). For the quantification of anthocyanin content, Carotenoids activity when subjected to wavelengths of 530, 620 and 650 Kingstone pride depicted maximum anthocyanin activity (Figure 5d, e and f).

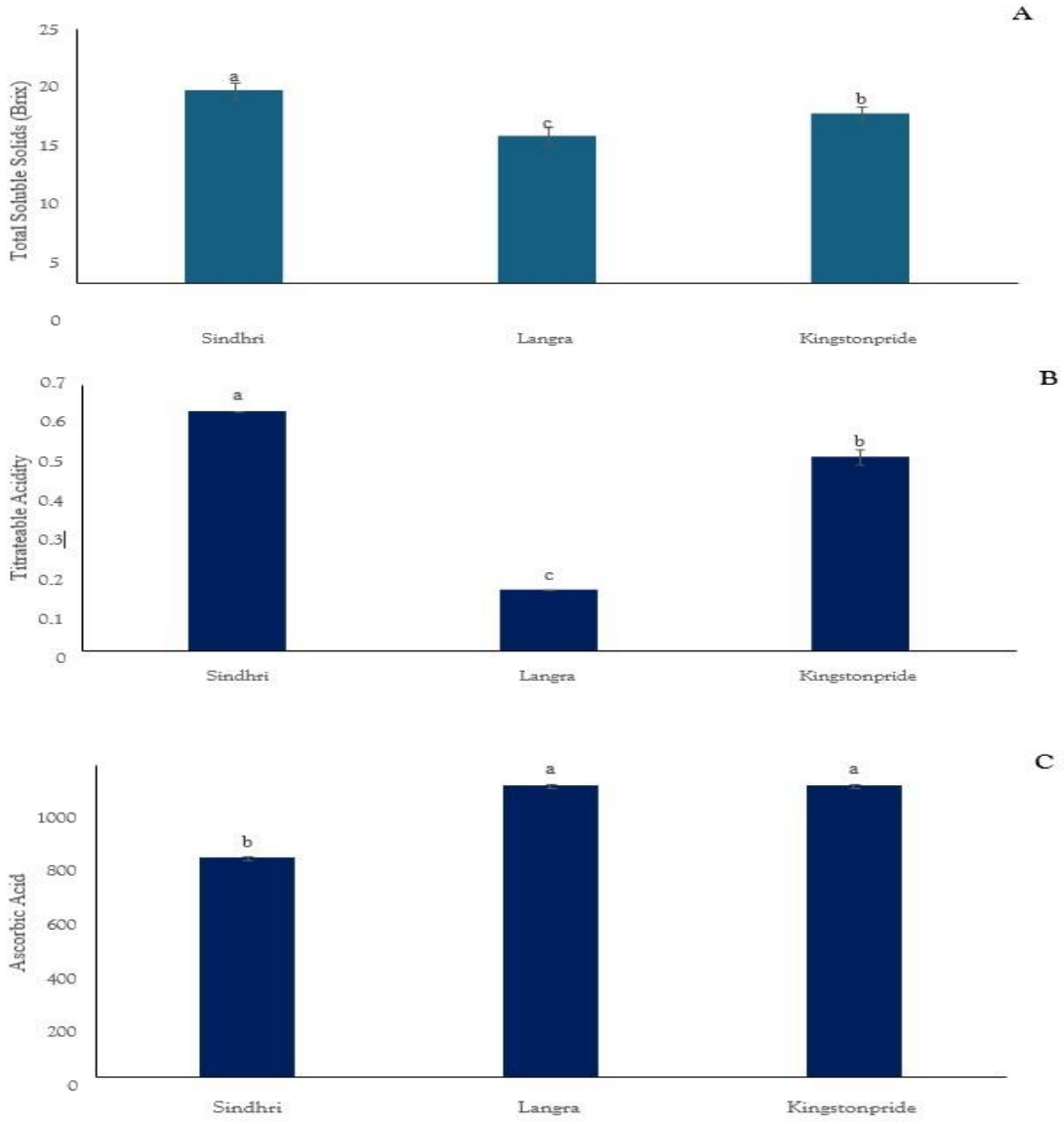

Figure 3. Total Soluble Solids (3a), Titrateable Acidity (3b) and Ascorbic Acid content (3c) of 3 Mango Varieties. Data compiled from the average of three replicates, with vertical bars indicating the standard deviation of the means. Mean values having different superscript letters differs significantly ($P < 0.05$).

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Volume 2, Issue 3, 2025

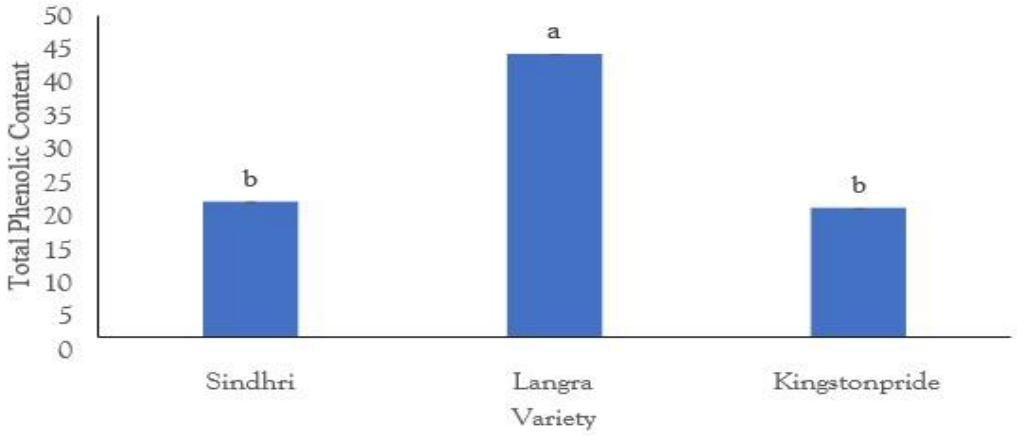

Figure 4. Total Phenolic Content of three different mango varieties. Data compiled from the average of three replicates, with vertical bars indicating the standard deviation of the means. Mean values having different superscript letters differs significantly (P < 0.05).

DISCUSSION

This study aims to evaluate and characterize three different *Mangifera indica* varieties i.e. Sindhri, Langra, Kingstone pride grown in South Punjab region using a morpho-biochemical approach. Factorial analysis revealed that all examined traits effectively characterized mango cultivars. Similar studies conducted on local mango varieties showed continuous diversity in pomological traits; however, the current study indicated a lower degree of variation (Kher et al., 2002). This may be attributed to the genetic makeup of each variety, which shapes distinct traits and is significantly influenced by environmental factors.

Mean value of fruit length measurement showed meaningful variation extended from 15.8 to 11.7 cm our outcomes are in confirmation with Shahid et al., (2024) and Kher and Sharma (2002). Fruit width depicted significant variation which is in agreement with previous studies Bora et al. (2017) and Kher and Sharma (2002).

The average fruit weight ranged from 646g to 410g, which showed high degree of variation which may be due to difference in respiration rates of different varieties (Shahid et al., 2024). Peel Weight was observed between 73.8 to 65.8g didn't indicated significance among varieties which is in confirmation with Shahid et al., (2024). It is evident from figure Figures 2c and 2d, Langra also had the greatest peel and stone weights, measuring 73.8g and 57.4g, respectively showing somehow significant variations, confirmed by Bora et al. (2017).

Biochemical traits of fruits—such as TSS, TA, ascorbic acid, sugars, antioxidants, and phenolics— are crucial for ensuring a high-quality cultivar or variety. Attributes like taste, texture, aromatic volatiles, and these biochemical characteristics collectively contribute to the overall excellence of mango (Navak et al., 2013). TSS content ranged from

18.9 to 14.4, Sindhri (18.9) and Kingstone pride (16.6) depicted high Soluble Solids content as compare to Langra variation in TSS content is supported by Bora et al., (2017). Maximum titratable acidity was found in Sindhri (0.63%), overall, it ranged from 0.63% to 0.16% showed high degree of variation. Wide degree of variation in different mango varieties was also supported by Bora et al., (2017) and Bakhshi and Bajwa, (1959). No significant difference was noted among Langra and Kingstone pride in case of Ascorbic acid content while Sindhri depicted low ascorbic acid can be attributed to the genetic diversity and range present in the experimental material Mitra et al. (2001). When the ascorbic acid content of various mango types was analyzed, it was found that Kingstone Pride and Langra had comparable levels, suggesting that there was no discernible difference between the two. The ascorbic acid concentration of the Sindhri variety, on the other hand, was significantly lower, ranging from 844 to 1122 mg/100g.

The total phenolic content exhibited notable variation, ranging from 44 to 20 mg GAE/g DW, aligning

somewhat with findings by Liu et al. (2013). The natural appearance of fruit, reflected by its total carotenoid content, provides specific benefits,especially in international trade, where the use of artificial color additives is prohibited. Carotenoid and anthocyanin levels were measured at wavelengths of 662, 645, and 470 nm for carotenoids, and 530, 620, and 650 nm for anthocyanins. Kingstone Pride displayed the highest activity for both carotenoids and anthocyanins on different wavelengths. Variations in carotenoid content have been noted by Hoda et al. (2003).

Quantification of peroxidase (POX) activity revealed nearly identical values for the Sindhri and Langra varieties (1.92), while Kingstone Pride exhibited the lowest activity (0.04). These findings align somewhat with Liu et al. (2013)'s research, with observed differences potentially attributed to environmental factors. In case of CAT activity, a range of value from 0.09 to 0.085 was quantified with no significant varation, which is different from the findings of Shahid et al., (2024).

CONCLUSION

Evaluation and characterization utilizing three different *Mangifera indica* varieties Sindhri, Langra, and Kingstone pride grown in the South Punjab region using a morpho-biochemical approach depicted the hypothesis that substantial variation exists among different genotypes based on their morpho-biochemical characteristics. Results concludes that in among these varieties Langra has better morphological traits than Sindhri and Kingstone pride while in terms of fruit quality Sindhri was best. Moreover, Kingstone pride depicted better antioxidative properties. Detailed characterization is therefore an essential step for starting a breeding program.

REFERENCES

Bakhshi, J. C., & Bajwa, B. S. (1959). Studies on varietal differences in fruit quality of the mango varieties grown in the Punjab. *Indian Journal of Horticulture*, *16*(4), 216-220.

Bompard, J. M. (1992). The genus Mangifera re-discovered: the potential contribution of wild species to mango cultivation. In *IV International Mango Symposium 341* (pp. 69-77).

Bora, L., Singh, A. K., & Singh, C. P. (2017). Characterization of mango (*Mangifera indica* L.) genotypes based on physio-chemical quality attributes. *Journal of Applied and Natural Science*, *9*(4), 2199-2204.

Chen, Z., Wang, Y., Wang, T., Li, S., Xiong, B., Qiu, X. & Wang, Z. (2020). Comparative Study on Biological Characteristics and Fruit Quality Changes of Two Citrus Varieties. In *IOP Conference Series: Earth and Environmental Science* (Vol. 474, No. 3, p. 032020). IOP Publishing.

Gálvez-López, D., Salvador-Figueroa, M., Adriano-Anaya, M. L., & Mayek-Pérez, N. (2010). Morphological characterization of native mangos from Chiapas, Mexico. *Subtropical Plant Science*, *62*, 18-26.

Hoda, M. N., Sanjay Singh, S. S., & Jayant Singh, J. S. (2003). Evaluation of ecological groups of mango (*Magnifera indica*) cultivars for flowering and fruiting under Bihar conditions. *Indian Journal of Agricultural Sciences*.73(2), 101-105.

Igbari, A. D., Nodza, G. I., Adeusi, A. D., & Ogundipe, O. T. (2019). Morphological characterization of mango (*Mangifera indica* L.) cultivars from south-west Nigeria. *Ife Journal of Science*, *21*(1), 155-163.

Khan, A. S., Ali, S., & Khan, I. A. (2015). Morphological and molecular characterization and evaluation of mango germplasm: An overview. *Scientia Horticulturae*, *194*, 353-366.

Kher, R., & Sharma, R. M. (2002). Performance of some mango cultivars under sub-tropical rainfed region of Jammu. *Haryana Journal of Horticultural Sciences*, *31*(1/2), 8-9.

Krishna, H., & Singh, S. K. (2007). Biotechnological advances in mango (*Mangifera indica* L.) and their future implication in crop improvement—a review. *Biotechnology Advances*, *25*(3), 223-243.

Lebaka, V. R., Wee, Y. J., Ye, W., & Korivi, M. (2021). Nutritional composition and bioactive compounds in three different parts of mango fruit. *International journal of environmental research and public health*, *18*(2), 741.

Liu, D., Zou, J., Meng, Q., Zou, J., & Jiang, W. (2009). Uptake and accumulation and oxidative stress in garlic (*Allium sativum* L.) under lead phytotoxicity. *Ecotoxicology*, *18*, 134-143.

Liu, F. X., Fu, S. F., Bi, X. F., Chen, F., Liao, X. J., Hu, X. S., & Wu, J. H. (2013). Physico-chemical and antioxidant properties of four mango (*Mangifera indica* L.) cultivars in China. *Food chemistry*, *138*(1), 396-405.

Mitcham, B., Cantwell, M., & Kader, A. (1996). Methods for determining quality of fresh commodities. *Perishables handling newsletter*, *85*, 1-

Nayak, D., Singh, A. K., & Srivastav, M. (2013). Estimation of genetic parameters of fruit quality traits in mango hybrid population. *Indian Journal of Horticulture*, *70*(1), 13-17.

Shahbaz, M., Akram, A., Raja, N. I., Mukhtar, T., Mehak, A., Fatima, N. & Abasi, F. (2023). Antifungal activity of green synthesized selenium nanoparticles and their effect on physiological, biochemical, and antioxidant defense system of mango under mango malformation disease. *PLoS One*, *18*(2), e0274679.

Shahid, A., Ikhlaq, M., Noreen, A., Amjad, M. A., Bashir, M. A., Rasool, F., & Latif, A. (2024).Characterization of Different Mango (*Mangifera indica*) Varieties of South Punjab.

Siddiqui, S. H., Aktar, N., & Sultana, C. (2015). A study on mango economy of Malda district, West Bengal. *National geographical journal of India*, *61*(02), 129-140.

Singh, N. K. (2016). Origin, diversity and genome sequence of mango (*Mangifera indica* L.). *Indian Journal of History of Science*, *51*(2.2), 355.

Mitra, S., Kundu, S., & Mitra, S. K. (2001). Evaluation of local strains of mango (*Mangifera indica*) grown in West Bengal. *The Indian Journal of Agricultural Sciences*, *71*(7), 466-468.