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Research article

Postharvest quality and ripening behaviour of un-explored genotypes of Himalayan plain mango diversity

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ABSTRACT

India is renowned for its mango diversity, with more than 1000 genotypes reported. However, the Himalayan plains bear some elite genotypes which supposed to bear high postharvest value, the systemic postharvest study of which is yet to be attempted. The aim of present study is to evaluate the postharvest quality and ripening behviour of these important genotypes. Thus, 15 un-explored mango genotypes of this region were selected and evaluated for ripening behaviour and detailed postharvest profiling *via* internal (total phenolic and total flavonoid content), nutritional attributes (Brix: acid ratio, total carotenoid concentration, ascorbic acid content and antioxidant activity), sensory evaluation, fruit softening enzymes (polygalactouronase, pectin methylesterase and lipoxygenase), shelf life attributes (respiration rate, physiological loss in weight and storage life in days) external attributes (fruit weight, fruit firmness, peel thickness, fruit shape and dry seed weight) and mineral contents (Calcium, potassium and phosphorous) under ambient storage (25 ± 4 °C and 65 ± 5 % RH). The results revealed that the highest total flavonoid content (682.40 μg g^{-1}), ascorbic acid (46.88 mg 100 g^{-1}) and antioxidant activity (4.84 μmol TE g^{-1}) exhibited by 'Sukul'. The total phenolic content was recorded as the highest in 'Safed Malda' (510.42 μg GAE g-1 FW), and total carotenoid concentration was recorded as the highest in 'Sipiya' (7.30 mg 100 g-1) 'Zardalu' (7.04 mg 100 g-1) and 'Mithua' (6.98 mg 100 g-1). Interestingly, genotypes such as 'Sukul', Sipiya' and 'Krishna Bhog 'exhibited a 4–5 days higher storage life than other selected genotypes. Screened genotypes exhibited a high diversity of nutritional

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and biochemical contents. The results of this study bear practical utility for research (quality improvement programme) and the processing industry.

1. Introduction

Mango is one of the choicest fruit crops grown in tropical and subtropical regions of the world [1,2]. The mango originated in South Asia from where it expanded to other parts of the world. Over 55.38 million metric tonnes of mangoes are thought to be produced worldwide each year, with India leading with over 40 % of the total production of 22.35 million tonnes from an area of 2.31 million ha cases [3,4]. The nutritional composition of mango fruits varies significantly across different genotypes and stages of fruit development. Mangoes are prized for their delightful taste and captivating aroma, both of which are crucial for winning over consumers preference [5]. The rich genetic diversity found within the mango species opens up exciting opportunities for harnessing genomic resources to enhance desirable attributes [6]. It's worth noting that mango fruits exhibit an astonishing range of diversity, with each genotype possessing its distinct flavour and unique qualities [7]. As mangoes ripen during ambient storage, they undergo a series of sequential transformations encompassing changes in physical characteristics, physiological processes, nutritional content, biochemical composition, enzyme activities, colouration, flavour, and aroma [8,9].

Mango fruits are very nutritious, contain vitamins, minerals etc., and are regarded as a good source of dietary antioxidants [4,10]. Mango is a particularly good source of polyphenols and micronutrients with distinct health benefits [11,12]. Mango is designated as a functional food because it provides micro- and macro-nutrients with bioactive compounds [13]. Ripe mangoes are enjoyed as desserts in the majority of countries throughout the world and are also processed into various products [3]. Researchers continuously envisage un-explored genotypes of this important crop, which are still un-attempted to determine their immense postharvest phytochemical and neutraceutical value.

The Himalayan plain region bears a huge diversity of indigenous mango genotypes which vary in postharvest quality and ripening behaviour. These indigenous mango genotypes are a rich source of nutritional as well as biochemical attributes [4,6]. Some indigenous un-explored mango genotypes in the Himalayan plain region have not yet been assessed for postharvest quality and ripening behaviour [4]. Present experiment was conducted with an aim to identify the superiority of Himalayan plain genotypes with respect to postharvest quality, phytochemicals, and ripening behaviour under ambient storage. The results bear practical utility for the postharvest quality improvement program and for the processing industry.

2. Materials and methods

2.1. Materials

The experiment was conducted at the Department of Horticulture, Tirhut College of Agriculture (TCA), at Dr. Rajendra Prasad Central Agricultural University (RPCAU), located in Pusa, Bihar-843121, India. From May to August, 15 different indigenous mango genotypes were carefully harvested from the mango orchard belonging to the institute, RPCAU, Pusa, Bihar. Upon harvesting, the fruits were transported to the laboratory, where they underwent a desapping process. This involved placing the fruits upside-down in a desapper until all the exudate had completely oozed out. Following this, the mangoes were promptly subjected to hydrocooling, which effectively brought their temperature to a uniform level across all the different varieties. The fruits were stored under ambient storage (25 ± 4 °C and 65 ± 5 % Relative Humidity). The observation was recorded on internal (total phenolic content and total flavonoids), nutritional attributes (Brix: acid ratio, total carotenoid concentration, ascorbic acid and antioxidant activity), sensory evaluation, fruit softening enzymes activity (PG, PME and LOX), shelf life attributes (respiration rate, PLW and storage life in days) and external attributes (fruit weight, fruit firmness, peel thickness, fruit shape and dry seed weight) and mineral contents (Calcium, potassium and phosphorous) under ambient storage. The external attributes such as fruit weight, peel thickness, fruit shape, dry seed weight and mineral contents were estimated at the peak ripe stage. Observations on different attributes during storage were noted at 3-day intervals up to the 12th day.

2.2. Internal attributes

2.2.1. Total phenolic content (TPC)

The TPC of mango pulp was estimated according to the methodology opted by Prasad et al. [14]. Double-distilled water (2.5 mL) in a test tube was used to dilute the (0.5 mL) pulp, and after the addition of 0.5 mL Folin–Ciocalteu reagent, it was incubated for 3 min. Following incubation, 2 mL of 20 % (w/v) Na_2CO_3 was added to the sample tube and kept for 1 min for boiling in the water bath. At 650 nm absorbance was recorded and using gallic acid (GA) solutions standard curve was plotted. The results of TPC were represented as 'μg GAE g^{-1} FW'.

2.2.2. Total flavonoid contents (TFC)

TFC was measured as per the methodology followed by Lenucci et al. [15]. Aluminium chloride was used for the estimation of TFC. Absorbance was recorded using spectrophotometer (Model: IGENE LABSERVE, IG 94UV, India) at 510 nm. The results were presented as 'μg g^{-1}'.

2.3. Nutritional attributes

2.3.1. Brix: acid ratio

The Brix: acid ratio was estimated by dividing the Brix value by that of the percentage of titratable acidity [16].

2.3.2. Total carotenoid concentration (TCC)

The TCC was evaluated according to the procedure followed by Prasad et al. [6]. To homogenise 20 g of fruit pulp, 60 mL of acetone was used. To obtain the golden pigment, a homogenised solution was placed in a separating funnel and washed with petroleum ether containing a pinch of sodium sulphate. For the pigment separation, funnels were shaken and left undisturbed. Coloured pigment solution was transferred into the volumetric flask. The blank was prepared using petroleum ether. Spectrophotometer was used for recording sample's absorbance at 452 nm and the results were presented as 'mg 100 g^{-1} FW'.

2.3.3. Ascorbic acid content (AAC) and antioxidant (AOX) activity

AAC was measured using 2,6-Dichlorophenol indophenol titration method as followed by Megha et al. [3]. The reagents used in the estimation were 3 % metaphosphoric acid (HPO_3), ascorbic acid standard, and a dye solution. The dye was standardized by finding the dye factor, that is, mg ascorbic acid/ml of the dye using the equation: 0.5/Titre value = Dye factor. To prepare the sample, 10 mL of juice was taken. The volume was brought up to 100 ml with 3 % HPO_3, filtered, and centrifuged. The fruit sample was kept in a conical flask for its titration with standardized dye. The results of ascorbic acid were expressed as 'mg 100 g^{-1} pulp'. AOX activity of mango genotypes was estimated using CUPRAC method followed by Prasad et al. (2022a). The results of AOX were expressed in terms of 'μmol TE g^{-1}'.

2.4. Fruit softening enzyme

2.4.1. Polygalactouronase (PG), pectin methylesterase (PME) and lipoxygenase (LOX) activity

The polygalacturonase (PG) activity of mango genotypes was estimated as per the methodology followed by Saroj and Prasad [4]. Enzyme extract (0.2 mL) was treated with an assay mixture (2 mL) and left for incubation at 37 °C for couple of hours. After incubation, 0.5 mL incubated mixture was treated with 1 mL of 5 % phenol and subjected to the addition of 5 mL H_2SO_4 (96 %) for reaction. The mix was diluted with distilled water (5 mL). The blank was prepared by the addition of distilled water to the assay mixture. The absorbance was recorded at 490 nm using a spectrophotometer. The results were presented as 'μg galacturonic acid g^{-1} h^{-1} FW'.

The pectin methylesterase (PME) activity of mango fruits was evaluated using the methodology opted by Prasad et al. [9]. The reagents utilized for PME estimation were 0.5 % (w/v) pectin solution, 8.5 % (w/v) NaCl, and 0.01 % (w/v) bromothymol blue solution. At 620 nm absorbance was recorded with the help of spectrophotometer. The results were presented as 'μmol g^{-1} FW min^{-1}'.

The Lipoxygenase (LOX) activity of mango fruit was determined according to the procedure followed by Prasad et al. [14]. The substrate includes linoleic acid and 35 μL Tween-20 reagent. The phosphate buffer (0.1 M concentration) was utilized for final volume (100 mL) preparation. EDTA (10 mL) was used for the pulp (1 g) homogenization followed by distillate homogenization (15,000 × for 20 min at 4 °C). The substrate solution (2.975 mL) was subjected to 50 μL enzyme extract followed by recording the absorbance on 0.5-min intervals up to 4 min at 234 nm. The results were determined using the equation $\Delta A = \varepsilon C\lambda$. (where delta A is absorbance change and ε is "Molar extinction coefficient" $2500\lambda - 1$, while C was calculated. The absorbance was recorded on 0.5-min intervals up to 4 min at 234 nm. The results were presented in terms of 'μmol g^{-1} FW min^{-1}'.

2.5. Shelf-life attributes

2.5.1. Respiration rate

The rate of respiration was determined as per the methodology used by Prasad et al. [14]. "Autogas analyzer" was used for this purpose (Model: Checkmate 3 O2 (Zr) CO2-100 % w/Printer, Dansensor, PBI, Denmark). The results were presented as 'ml CO_2 kg^{-1} h^{-1}'. The following equation was utilized for calculating the rate of respiration.

$$Respiration\ rate = \frac{Evolved\ CO_2(\%) \times container's\ Head\ space\ (ml) \times 100}{Weight\ of\ trapped\ fruit\ in\ kg \times Time\ (h)} \quad (1)$$

2.5.2. Physiological loss in weight (PLW) and storage life (days)

Mango fruit's physiological loss in weight (PLW) was measured using a 'High precision electronic balance' (Make: Pricisa 310 M). Fruits that exhibited PLW loss of more than 10 % were deemed to have completed their storage life [4]. The storage life was measured by a 10 % physiological loss in weight.

2.6. Sensory evaluation

2.6.1. Fruit sensory score

Fruit sensory score was evaluated using the hedonic scale method [14]. Mango fruit sensory score was evaluated based on colour, aroma, flavour, texture and mouthfeel. The panel of 25 semi-trained judges gave feedback scores which were presented on a hedonic scale (1–9) [9].

2.7. External attributes

Fruit weight, fruit firmness, peel thickness, fruit shape and dry seed weight were determined. The weight of fruits and dry seeds was determined with the help of electronic balance and results were expressed as gram (g). A texture analyser (model: TA-XT Plus Stable Micro System, UK) was used to measure the firmness of mango fruits and represented Newton (N). The fruit peel thickness in mm was estimated using the vernier calipper. International Plant Genetic Resources Institute (IPGRI) mango descriptor was used to determine the mango fruit shape.

2.8. Mineral contents

2.8.1. Calcium, potassium and phosphorous

The mineral contents were measured as per the method used by Drozdz et al. [17]. Mango fruit samples were digested with di acids (Nitric acid and Perchloric acid) in ultrapure water acquired from the Mili Q system (Milipore, France). The Mili Q system was utilized for further dilution and digestion of the samples. Once the sample digestion was completed, it was filtered through ashless Whatman filter paper No. 4 of 20–25 μm pore size. The phosphorous reading was recorded at 440 nm using a spectrophotometer, while the flame photometer (Model no. EL 378, India) was used for calcium and potassium estimation, results were expressed as 'mg kg^{-1}'.

2.9. Statistical analysis

The experiment was carried out in "Two factor CRD design" with three replications, where factor 1 is the number of genotypes and factor 2 is storage days. The observation was observed at intervals of three days up to the 12th day. GraphPad (version 9) was used for data analysis. The Pearson correlation analysis was performed with significance levels set at $P < 0.05$, $P < 0.01$, and $P < 0.001$ denoting different degrees of significance—significant, quite significant, and highly significant, respectively. To explore the variations in physiological and biochemical characteristics among mangoes of various cultivars stored under ambient conditions, Principal Component Analysis (PCA) was employed for simplifying complex multivariate data, enabling the detection of underlying patterns and relationships among the variables.

3. Results and discussion

3.1. Internal attributes

3.1.1. Total phenolic content (TPC)

Our results revealed that the TPC content varied significantly among the selected mango genotypes. Irrespective of storage days, the TPC was recorded as the highest in 'Safed Malda' (510.42 μg GAE g^{-1} FW) whereas, 'Paharpur Sinduria recorded the lowest (300.62 μg GAE g^{-1} FW). Irrespective of genotypes, the TPC decreased throughout the storage period which might be due to the effect of softening and ripening process [4,14] (Table 1). Our results corroborate with the findings of Megha et al. [3] and Samal et al. [16] who observed the highest total phenolic content in 'Langra' (861.44 mg 100 g^{-1} FW) and 'Lajkuli Bandana' (105.6 mg 100 g^{-1}) over other selected genotypes. Such variation is also reported by Totad et al. [18] in blueberry varieties grown in the northern-western Himalayas. The genotypes exhibited high TPC are considered to be phytochemically rich and bear higher nutraceutical value [6].

Table 1
Total phenolic content (μg GAE g^{-1} FW) of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	498.40 ± 19.94^{ef}	453.20 ± 18.13^{d}	446.50 ± 17.86^{b}	310.20 ± 12.41^{f}	303.00 ± 12.12^{de}	402.26 ± 8.05^{f}
Fazli	590.50 ± 23.62^{bc}	577.50 ± 23.10^{a}	510.60 ± 20.42^{a}	467.50 ± 18.70^{a}	376.80 ± 15.07^{b}	504.58 ± 13.35^{ab}
Himsagar	475.70 ± 24.72^{f}	376.80 ± 19.58^{e}	343.10 ± 17.83^{d}	297.50 ± 15.46^{f}	215.00 ± 11.17^{g}	341.62 ± 13.66^{g}
Java	365.00 ± 9.66^{g}	342.70 ± 9.07^{e}	338.90 ± 8.97^{d}	315.40 ± 8.34^{f}	267.20 ± 7.07^{f}	325.84 ± 11.29^{gh}
Jawahar	490.50 ± 38.93^{f}	436.60 ± 34.65^{d}	384.60 ± 30.53^{c}	370.20 ± 29.38^{f}	320.30 ± 25.42^{cd}	400.44 ± 31.78^{f}
Kalkatiya Malda	468.60 ± 37.19^{f}	448.50 ± 35.60^{d}	385.70 ± 30.61^{c}	358.20 ± 28.43^{cde}	287.70 ± 22.84^{ef}	389.74 ± 7.79^{f}
Krishna Bhog	505.30 ± 26.26^{ef}	493.30 ± 25.63^{d}	452.20 ± 23.50^{b}	397.50 ± 20.65^{c}	267.90 ± 13.92^{f}	423.24 ± 11.20^{ef}
L-13	502.80 ± 10.26^{ef}	490.90 ± 9.82^{c}	460.50 ± 9.21^{b}	390.70 ± 7.81^{cd}	340.50 ± 6.81^{c}	437.08 ± 17.48^{de}
Mithua	555.50 ± 14.70^{cd}	542.70 ± 14.36^{b}	492.40 ± 13.03^{a}	394.50 ± 10.44^{c}	389.60 ± 10.31^{b}	474.94 ± 24.68^{bc}
Paharpur Sinduria	399.70 ± 15.99^{g}	360.50 ± 14.42^{e}	270.50 ± 10.82^{e}	250.30 ± 10.01^{g}	222.10 ± 8.88^{g}	300.62 ± 12.02^{h}
Sabri	533.40 ± 18.48^{de}	510.60 ± 17.69^{bc}	460.30 ± 15.95^{b}	436.80 ± 15.13^{b}	388.90 ± 13.47^{b}	466.00 ± 24.21^{cd}
Safed Malda	606.00 ± 16.03^{b}	540.60 ± 14.30^{b}	500.00 ± 13.23^{a}	462.30 ± 12.23^{ab}	443.20 ± 11.73^{a}	510.42 ± 17.68^{a}
Sipiya	600.70 ± 15.89^{b}	586.50 ± 15.52^{a}	496.60 ± 13.14^{a}	443.10 ± 11.72^{ab}	324.10 ± 8.57^{cd}	490.20 ± 38.91^{abc}
Sukul	665.40 ± 13.31^{a}	512.40 ± 10.25^{bc}	443.40 ± 8.87^{b}	365.20 ± 7.30^{de}	314.70 ± 6.29^{d}	460.22 ± 9.20^{cd}
Zardalu	500.00 ± 13.23^{ef}	487.30 ± 12.89^{c}	412.20 ± 10.91^{c}	355.60 ± 9.41^{e}	310.20 ± 8.21^{de}	413.06 ± 10.93^{ef}
Mean	517.167 ± 19.85^{1}	477.34 ± 18.33^{2}	426.5 ± 16.32^{3}	374.333 ± 14.5^{4}	318.08 ± 12.12^{5}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

3.1.2. Total flavonoid content (TFC)

Flavonoids are a group of polyphenol chemicals that exhibit different biological and chemical properties (anti-inflammatory, antioxidant, anticancer, antibacterial, and antiallergic activities) [4]. Among the attempted genotypes, the maximum TFC was exhibited by 'Sukul' (682.40 μg g^{-1}) while the minimum was exhibited by 'Himsagar' (311.44 μg g^{-1}) (Table 2). Irrespective of genotypes, the TFC increased up to 6th day of storage and then sharply declined thereafter. Our results support the finding of Veena et al. [19] who reported considerable variation in TFC among selected mango genotypes. The genotypes which bear high level of TFC are more phytochemically rich and nutritive and more suitable for desert as well as for processing purpose [4].

3.2. Nutritional attributes

3.2.1. Ascorbic acid content (AAC)

AAC is a paramount quality characteristic of fruits, especially valued for its antioxidant capacities [4]. Among selected genotypes, the maximum AAC was exhibited by 'Sukul' (46.88 mg 100 g^{-1}) whereas, 'Mithua' (16.84 mg 100 g^{-1}) 'Himsagar' (17.12 mg 100 g^{-1}), and Paharpur Sinduria' (17.88 mg 100 g^{-1}) exhibited the lower AAC (Table 3). Irrespective of genotypes, AAC decreased throughout the storage period. Such pattern might be due to oxidation, degradation, and ascorbic acid utilization in metabolic processes with ripening of fruits [14]. Our results support the findings of Samal et al. [16] who reported considerable differences in ascorbic acid among mango genotypes. They observed the higher AAC in 'Arka Neelkiran' (85.8 mg 100 g^{-1} pulp) and 'Langra Hazpuri' (84.60 mg 100 g^{-1} pulp). Similarly, Kumar et al. [20] reported differences in AAC among studied apple cultivars, as they recorded the highest AAC in 'Starkrimson' and 'Oregon spur'. The mango genotypes exhibiting higher AAC are nutritionally rich. High acid levels favour pickle making, thus mature unripe mangoes from such genotypes can be used for pickle making and green mango squash making in a cost-effective manner.

3.2.2. Antioxidant activity (AOX)

Fruit's health-promoting properties are mainly attributable to the presence of several antioxidant components [21]. Our results indicated that the storage days, genotypes, and its interaction influenced the antioxidant activity of mango genotypes. Among attempted genotypes, the highest antioxidant activity was registered in 'Sukul' (4.84 μmol TE g^{-1}) while the minimum was in 'Paharpur Sinduria' (1.70 μmol TE g^{-1}) (Table 4). The significant differences in AOX activity may be due to differences in total phenolic content, total carotenoid content and ascorbic acid content [22]. Initially, antioxidant activity increased up to the 6th day of storage and then declined thereafter, which might be due to antioxidant enzymes synthesis (catalase, superoxide dismutase, and peroxidase) during progress in storage days [23]. Jayarajan et al. [24] findings support our results who observed variation in AOX activity among attempted nectarine genotypes. They observed that 'Spring Bright' registered maximum antioxidant activity (24.10 μmol TE g^{-1}) while 'Missourie' registered the least (20.06 μmol TE g^{-1}). Genotypes exhibiting high AOX activity are highly preferred by health-conscious consumers and for development of the derived products such as green mango squash or mango leather *etc.* [4].

3.2.3. Total carotenoid concentration (TCC)

The carotenoids provide a natural colour to the pulp in ripe mango fruits and have several health advantages [25]. Irrespective of storage days, 'Sipiya' (7.30 mg 100 g^{-1}) 'Zardalu' (7.04 mg 100 g^{-1}) and 'Mithua' (6.98 mg 100 g^{-1}) recorded the higher TCC while the lowest was recorded in 'Krishna Bhog' (4.64 mg 100 g^{-1}) (Table 5). TCC increased with progress in storage days up to the 6th day and then decreased thereafter, which might be due to the relation of TCC with synthesis and ripening [26]. Farina et al. [5] and Samal

Table 2
Total flavonoid content (μg g^{-1}) of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	421.00 ± 16.84^{d}	461.00 ± 18.44^{de}	520.00 ± 20.80^{cd}	470.00 ± 18.80^{e}	449.00 ± 17.96^{d}	464.2 ± 66.10^{de}
Fazli	270.00 ± 10.80^{g}	316.00 ± 12.64^{h}	404.00 ± 16.16^{f}	400.00 ± 16.00^{g}	372.00 ± 14.88^{f}	352.4 ± 26.63^{gh}
Himsagar	280.20 ± 14.56^{g}	312.00 ± 16.21^{h}	355.00 ± 18.45^{g}	321.00 ± 16.68^{h}	289.00 ± 15.02^{g}	311.44 ± 21.1^{h}
Java	320.00 ± 8.47^{f}	350.00 ± 9.26^{g}	398.00 ± 10.53^{f}	360.00 ± 9.52^{h}	312.00 ± 8.25^{g}	348 ± 97.69^{gh}
Jawahar	398.00 ± 31.59^{de}	475.00 ± 37.70^{d}	512.00 ± 40.64^{cd}	509.00 ± 40.40^{d}	490.00 ± 38.89^{bc}	476.8 ± 8,03^{de}
Kalkatiya Malda	398.00 ± 31.59^{de}	430.00 ± 34.13^{ef}	510.00 ± 40.48^{cd}	453.00 ± 35.96^{ef}	410.00 ± 32.54^{e}	440.2 ± 18.72^{ef}
Krishna Bhog	380.70 ± 19.78^{e}	400.00 ± 20.78^{f}	450.00 ± 23.38^{e}	422.00 ± 21.93^{fg}	410.00 ± 21.30^{e}	412.54 ± 8.32^{f}
L-13	390.00 ± 7.80^{de}	420.00 ± 8.40^{f}	487.00 ± 9.74d^{e}	467.00 ± 9.34^{e}	310.00 ± 6.20^{g}	414.8 ± 69.53^{f}
Mithua	520.00 ± 13.76^{b}	560.00 ± 14.82^{b}	632.00 ± 16.72^{b}	553.00 ± 14.63^{c}	476.00 ± 12.59^{cd}	548.19 ± 68.68^{c}
Paharpur Sinduria	400.00 ± 16.00^{de}	485.00 ± 19.40^{cd}	500.00 ± 20.00^{d}	430.00 ± 17.20^{fg}	412.00 ± 16.48^{e}	445.4 ± 51.44^{ef}
Sabri	278.00 ± 9.63^{g}	307.00 ± 10.63^{h}	450.00 ± 15.59^{e}	430.00 ± 14.90^{fg}	400.00 ± 13.86^{ef}	373 ± 116.01^{g}
Safed Malda	540.00 ± 14.29^{b}	576.00 ± 15.24^{b}	657.00 ± 17.38^{b}	540.00 ± 14.29^{cd}	633.00 ± 16.75^{a}	589.20 ± 19.99^{b}
Sipiya	550.00 ± 14.55^{b}	512.00 ± 13.55^{c}	630.00 ± 16.67^{b}	600.00 ± 15.87^{b}	512.00 ± 13.55^{b}	560.8 ± 93.04^{bc}
Sukul	676.00 ± 13.52^{a}	690.00 ± 13.80^{a}	720.00 ± 14.40^{a}	687.00 ± 13.74^{a}	639.00 ± 12.78^{a}	682.4 ± 110.0^{a}
Zardalu	470.00 ± 12.44^{c}	465.00 ± 12.30^{d}	540.00 ± 14.29^{c}	512.00 ± 13.55^{d}	481.00 ± 12.73^{bcd}	493.6 ± 13.00^{d}
Mean	419.46 ± 14.69^{5}	450.60 ± 16.23^{4}	517.67 ± 18.60^{1}	476.93 ± 18.18^{2}	439.67 ± 16.91^{3}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

Table 3
Ascorbic acid content (mg 100 g^{-1} pulp) of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	54.5 ± 2.18^{ab}	49.9 ± 2.00^{ab}	41.2 ± 1.65^{b}	34.5 ± 1.38^{c}	31.2 ± 1.25^{c}	42.26 ± 0.85^{b}
Fazli	38.65 ± 1.53^{e}	36.5 ± 1.46^{e}	30.3 ± 1.21^{e}	13.2 ± 0.53^{f}	10.3 ± 0.41^{fg}	25.70 ± 0,68^{e}
Himsagar	28.70 ± 1.49^{g}	23.2 ± 1.21^{h}	15.3 ± 0.80^{h}	10.1 ± 0.52^{g}	8.3 ± 0.43^{h}	17.12 ± 0.68^{g}
Java	36.50 ± 0.97^{e}	31.5 ± 0.83^{f}	25.8 ± 0.68^{f}	17.3 ± 0.46^{e}	14.1 ± 0.37^{e}	25.04 ± 0.87^{e}
Jawahar	47.30 ± 0.75^{d}	42.2 ± 3.35^{d}	44.2 ± 3.51^{a}	36.6 ± 2.91^{b}	32.1 ± 2.55^{c}	40.48 ± 3.21^{bc}
Kalkatiya Malda	32.60 ± 2.59^{f}	27.9 ± 2.21^{g}	22.2 ± 1.76^{g}	15.9 ± 1.26^{e}	11.5 ± 0.91^{f}	22.02 ± 0.44^{f}
Krishna Bhog	35.60 ± 1.85^{ef}	30.3 ± 1.57^{fg}	23.3 ± 1.21^{g}	16.8 ± 0.87^{e}	13.1 ± 0.68^{e}	23.82 ± 0.63^{ef}
L-13	35.10 ± 0.70^{ef}	30.8 ± 0.62^{f}	23.6 ± 0.47^{fg}	16.7 ± 0.33^{e}	13.6 ± 0.27^{e}	23.96 ± 0.96^{ef}
Mithua	25.50 ± 0.67^{g}	21.7 ± 0.57^{h}	16.6 ± 0.44^{h}	11.2 ± 0.30^{g}	9.2 ± 0.24^{gh}	16.84 ± 0.88^{g}
Paharpur Sinduria	28.40 ± 1.14^{g}	24.6 ± 0.98^{h}	17.3 ± 0.69^{h}	10.2 ± 0.41^{g}	8.9 ± 0.36^{gh}	17.88 ± 0.72^{g}
Sabri	35.80 ± 1.24^{e}	30.8 ± 1.07^{f}	24.6 ± 0.85^{fg}	17.7 ± 0.61^{e}	14.4 ± 0.50^{e}	24.66 ± 1.28^{e}
Safed Malda	47.10 ± 1.25^{d}	42.4 ± 1.12^{d}	37.5 ± 0.99^{d}	29.5 ± 0.78^{d}	26.6 ± 0.70^{d}	36.62 ± 1.27^{d}
Sipiya	52.40 ± 1.39^{bc}	47.7 ± 1.26^{bc}	40.4 ± 1.07^{bc}	37.2 ± 0.98^{b}	34.8 ± 0.92^{b}	42.5 ± 3.37^{b}
Sukul	56.20 ± 1.12^{a}	51.5 ± 1.03^{a}	45.5 ± 0.91^{a}	41.3 ± 0.83a	39.9 ± 0.80^{a}	46.88 ± 0.94^{a}
Zardalu	50.7 ± 1.34^{c}	45.9 ± 1.21^{c}	38.4 ± 1.02^{cd}	30.4 ± 0.80d	26.4 ± 0.70^{d}	38.36 ± 1.01^{cd}
Mean	40.3 ± 1.34^{1}	35.7 ± 1.37^{2}	29.7 ± 1.15^{3}	22.5 ± 0.86^{4}	19.6 ± 0.73^{5}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

et al. [16] conducted similar research on mango cultivars. They observed that vitamin A content varied from 0.866 mg 100 g^{-1} to 1.082 mg 100 g^{-1} and 6721 μg 100 g^{-1} pulp to 3092 μg 100 g^{-1} pulp respectively. The TCC also provides natural colour to the value-added product such as ripe mango squash.

3.2.4. Brix: acid ratio

The Brix: acid ratio is one of the most often used techniques for assessing flavour which is more representative than individual sugar or acid quantification [3]. It is well known that a genotype's flavour and taste are influenced by the Brix-acid ratio. Irrespective of storage days, the higher Brix-acid ratio was exhibited by 'Zardalu' (105.36) and 'Himsagar' (104.48) while the lowest was exhibited by 'Sukul' (41.55) (Table 6). There is a correlation between our results and the findings reported by Megha et al. [3], in that the genotypes with higher acid content are preferred for pickling, while the genotypes with higher TSS are preferred for desserts. They observed that Hybrid 811 has the highest Brix-to-acid ratio (115.88). The genotypes which exhibited higher Brix: acid ratio are suitable products like jams and juice while the genotypes exhibited lesser Brix: acid ratio are preferred for products like pickle making.

3.3. Fruit softening enzymes

3.3.1. Polygalactouronase (PG), pectin methylesterase (PME) and lipoxygenase (LOX)

The genotypes, storage days and interaction (genotypes × storage days) significantly influenced the PG activity. Irrespective of the storage period, the highest PG activity was recorded in 'Java' (35.30 μg galacturonic acid g^{-1} h^{-1} FW) whereas, 'Sukul' recorded the

Table 4
Antioxidant activity (μmol TE g^{-1}) of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	2.13 ± 0.09^{b}	3.57 ± 0.14^{b}	5.55 ± 0.22^{b}	4.23 ± 0.17^{c}	4.11 ± 0.16^{b}	3.92 ± 0.08^{b}
Fazli	0.43 ± 0.02^{j}	2.21 ± 0.09^{f}	3.41 ± 0.14^{fg}	2.56 ± 0.10^{f}	2.45 ± 0.10^{g}	2.21 ± 0.06^{ef}
Himsagar	0.65 ± 0.03^{i}	1.81 ± 0.09^{g}	3.73 ± 0.19^{e}	2.14 ± 0.11^{h}	2.09 ± 0.11^{hi}	2.08 ± 0.08^{f}
Java	0.33 ± 0.01^{k}	1.53 ± 0.04^{h}	3.35 ± 0.09^{fg}	3.18 ± 0.08^{e}	3.08 ± 0.08^{e}	2.29 ± 0.08^{ef}
Jawahar	1.71 ± 0.14^{d}	2.21 ± 0.18^{f}	3.33 ± 0.26^{fg}	2.21 ± 0.18^{gh}	2.11 ± 0.17^{hi}	2.31 ± 0.18^{ef}
Kalkatiya Malda	0.79 ± 0.06^{h}	2.21 ± 0.18^{f}	3.61 ± 0.29^{ef}	2.26 ± 0.18^{gh}	2.12 ± 0.17^{hi}	2.20 ± 0.04^{ef}
Krishna Bhog	1.11 ± 0.06^{f}	2.54 ± 0.13^{e}	3.56 ± 0.18^{ef}	2.39 ± 0.12^{fg}	2.25 ± 0.12^{h}	2.37 ± 0.06^{de}
L-13	0.91 ± 0.02^{g}	1.73 ± 0.03^{g}	3.31 ± 0.07^{ef}	2.32 ± 0.05^{gh}	2.15 ± 0.04^{hi}	2.08 ± 0.08^{f}
Mithua	0.23 ± 0.01^{k}	1.81 ± 0.05^{g}	3.23 ± 0.09^{g}	3.10 ± 0.08^{e}	2.67 ± 0.07^{f}	2.21 ± 0.11^{ef}
Paharpur Sinduria	0.25 ± 0.01^{k}	1.47 ± 0.06^{h}	2.85 ± 0.11^{h}	2.24 ± 0.09^{gh}	1.67 ± 0.07^{j}	1.70 ± 0.07^{g}
Sabri	1.32 ± 0.05^{e}	2.62 ± 0.09^{e}	4.31 ± 0.15^{cd}	3.78 ± 0.13^{d}	3.67 ± 0.13^{c}	3.14 ± 0.16^{c}
Safed Malda	1.94 ± 0.05^{c}	2.89 ± 0.08^{d}	4.51 ± 0.12^{c}	3.71 ± 0.10^{d}	3.42 ± 0.09^{d}	3.29 ± 0.11^{c}
Sipiya	2.10 ± 0.06^{b}	3.67 ± 0.10^{b}	5.47 ± 0.14^{b}	4.45 ± 0.12^{b}	4.16 ± 0.11^{b}	3.97 ± 0.32^{b}
Sukul	2.51 ± 0.05^{a}	4.41 ± 0.09^{a}	6.32 ± 0.13^{a}	5.51 ± 0.11^{a}	5.43 ± 0.11^{a}	4.84 ± 0.10^{a}
Zardalu	1.23 ± 0.03^{e}	3.28 ± 0.09^{c}	4.19 ± 0.13^{d}	2.10 ± 0.06^{h}	1.98 ± 0.05^{i}	2.56 ± 0.07^{d}
Mean	1.18 ± 0.04^{5}	2.53 ± 0.09^{4}	4.05 ± 0.15^{1}	3.08 ± 1.30^{2}	2.89 ± 0.09^{3}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

Table 5
Total carotenoid concentration (mg 100 g^{-1}) of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	2.60 ± 0.10^{fg}	5.20 ± 0.21^{b}	6.10 ± 0.24^{f}	5.70 ± 0.23^{de}	5.30 ± 0.21^{i}	4.98 ± 0.10^{ef}
Fazli	3.20 ± 0.13^{de}	4.50 ± 0.18^{c}	8.20 ± 0.33^{b}	7.70 ± 0.31^{b}	7.50 ± 0.30^{b}	6.22 ± 0.16^{b}
Himsagar	2.70 ± 0.14^{fg}	4.60 ± 0.24^{c}	7.30 ± 0.38^{c}	7.00 ± 0.36^{c}	6.50 ± 0.34^{cde}	5.62 ± 0.22^{cd}
Java	3.10 ± 0.08^{e}	5.30 ± 0.14^{b}	8.20 ± 0.22^{b}	8.00 ± 0.21^{b}	6.90 ± 0.18^{c}	6.30 ± 0.22^{b}
Jawahar	2.80 ± 0.22^{f}	4.40 ± 0.35^{c}	6.70 ± 0.53^{de}	6.10 ± 0.48^{b}	5.90 ± 0.47^{fgh}	5.18 ± 0.41^{de}
Kalkatiya Malda	3.40 ± 0.27^{cd}	4.60 ± 0.37^{c}	7.50 ± 0.60^{c}	7.10 ± 0.56^{c}	6.90 ± 0.55^{c}	5.90 ± 0.12^{bd}
Krishna Bhog	2.50 ± 0.13^{g}	4.40 ± 0.23^{c}	5.80 ± 0.30^{f}	5.50 ± 0.29^{a}	5.00 ± 0.26^{i}	4.64 ± 0.12^{f}
L-13	2.80 ± 0.06^{f}	5.30 ± 0.11^{b}	7.30 ± 0.15^{c}	6.70 ± 0.13^{c}	6.00 ± 0.12^{dfg}	5.62 ± 0.22^{cd}
Mithua	4.00 ± 0.11^{a}	5.00 ± 0.13^{b}	9.00 ± 0.24^{a}	8.80 ± 0.23^{a}	8.10 ± 0. 21^{a}	6.98 ± 0.36^{a}
Paharpur Sinduria	2.60 ± 0.10^{fg}	4.40 ± 0.18^{c}	7.10 ± 0.28^{cd}	6.70 ± 0.27^{c}	6.50 ± 0.26^{cd}	5.46 ± 0.22^{cde}
Sabri	3.60 ± 0.12^{bc}	5.30 ± 0.18^{b}	7.40 ± 0.26^{c}	6.80 ± 0.24^{c}	6.00 ± 0.21^{df}	5.82 ± 0.30^{bc}
Safed Malda	2.80 ± 0.07^{f}	4.20 ± 0.11^{c}	8.50 ± 0.22^{ab}	7.90 ± 0.21^{b}	7.40 ± 0.20^{b}	6.16 ± 0.21^{b}
Sipiya	3.70 ± 0.10^{b}	6.50 ± 0.17^{a}	9.00 ± 0.24^{a}	8.90 ± 0.24^{a}	8.40 ± 0.22^{a}	7.30 ± 0.58^{a}
Sukul	2.70 ± 0.05^{fg}	4.50 ± 0.09^{c}	6.30 ± 0.13^{ef}	6.00 ± 0.12^{de}	5.50 ± 0.11^{fhi}	5.00 ± 0.10^{ef}
Zardalu	3.80 ± 0.10^{ab}	6.50 ± 0.17^{a}	8.80 ± 0.23^{a}	8.50 ± 0.22^{a}	7.60 ± 0.20^{b}	7.04 ± 0.19^{a}
Mean	3.09 ± 0.11^{5}	4.98 ± 0.16^{4}	7.55 ± 0.29^{1}	7.16 ± 0.28^{2}	6.63 ± 0.22^{3}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

least (28.84 μg galacturonic acid g^{-1} h^{-1} FW) (Fig. 1). PG activity increased up to 9th day of storage then declined thereafter which might be due to its positive correlation with fruit ripening [9,27]. PME activity increased up to 6th day of storage and then declined thereafter, this might be due to its direct association with fruit ripening, softening and textural change processes [4]. Irrespective of storage days, the highest PME activity was observed in 'Kalkatiya Malda' (0.25 μmol g^{-1} FW min^{-1}) while the lowest was observed in 'Sukul' (0.15 μmol g^{-1} FW min^{-1}) (Fig. 2).

It was observed that the LOX activity varied significantly among attempted mango genotypes. Irrespective of storage days, the maximum LOX activity was observed in 'Paharpur Sinduria' (5.084 μmol g^{-1} FW min^{-1}) while the lowest in 'Sukul' (3.113 μmol g^{-1} FW min^{-1}) (Fig. 3). LOX enzyme is a senescence enzyme, it increased with progress in storage days up to 12th which might be due to association with senescence and fruit softening [6,28]. The significant differences among fruit softening enzymes might be due to differences that existed between genotypes. Such variations amongst fruit softening enzymes were investigated [4,9,14] in mango genotypes. Higher fruit-softening enzyme activity leads to a lowering in the storage life of fruit [9].

3.4. Shelf-life attributes

3.4.1. Respiration rate

One of the important parameters to determine the storage life is the reparation rate [22]. It was observed that during storage period, the highest respiration rate was exhibited by 'Kalkatiya Malda' (104.06 ml CO_2 kg^{-1} h^{-1}) while the lowest by 'Sukul' (74.17 ml CO_2 kg^{-1} h^{-1}) (Fig. 4). Irrespective of genotypes, it increased up to 6th day of storage then declined thereafter which might be due to

Table 6
Brix: acid ratio of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	18.78 ± 0.38^{i}	35.80 ± 1.43^{f}	47.10 ± 1.88^{de}	88.75 ± 1.78^{fg}	122.73 ± 2.45^{e}	62.63 ± 2.51^{d}
Fazli	21.69 ± 0.57^{gh}	27.32 ± 1.42^{h}	30.36 ± 1.58^{h}	78.57 ± 2.08^{h}	106.67 ± 2.82^{fg}	52.93 ± 2.75^{e}
Himsagar	32.24 ± 1.29^{b}	57.27 ± 2.29^{b}	61.52 ± 2.13^{b}	162.50 ± 6.50^{a}	208.89 ± 8.36^{a}	104.48 ± 4.18^{a}
Java	23.92 ± 0.83^{ef}	41.14 ± 2.14^{e}	43.71 ± 3.47^{e}	93.75 ± 3.25^{ef}	124.16 ± 4.30^{e}	65.34 ± 3.40^{d}
Jawahar	26.90 ± 2.13^{d}	45.00 ± 1.56^{d}	47.37 ± 0.95^{d}	148.33 ± 11.77^{b}	218.75 ± 17.36^{a}	97.27 ± 3.37^{b}
Kalkatiya Malda	25.47 ± 0.51^{de}	46.05 ± 3.66^{d}	51.84 ± 1.37^{c}	143.85 ± 2.88^{b}	180.00 ± 3.60^{b}	89.44 ± 7.10^{c}
Krishna Bhog	29.40 ± 0.78^{c}	56.20 ± 1.12^{bc}	61.38 ± 1.23^{b}	113.33 ± 3.00^{d}	168.00 ± 4.44^{c}	85.66 ± 1.71^{c}
L-13	22.55 ± 0.90^{fgh}	36.90 ± 0.98^{f}	39.52 ± 1.05^{f}	101.25 ± 4.05^{e}	123.08 ± 4.92^{e}	64.66 ± 1.71^{d}
Mithua	37.80 ± 1.96^{a}	53.55 ± 1.07^{c}	59.35 ± 2.37^{b}	128.57 ± 6.68^{c}	154.55 ± 8.03^{d}	86.76 ± 1.74^{c}
Paharpur Sinduria	23.85 ± 0.95^{ef}	46.13 ± 1.12^{d}	50.64 ± 1.75^{cd}	139.09 ± 5.56^{b}	187.50 ± 7.50^{b}	89.44 ± 2.37^{c}
Sabri	21.03 ± 1.09^{h}	31.32 ± 1.25^{g}	33.96 ± 2.70^{g}	83.81 ± 4.36^{gh}	94.44 ± 4.91^{g}	52.91 ± 2.12^{e}
Safed Malda	23.59 ± 0.82^{efg}	31.77 ± 1.10^{g}	34.32 ± 0.69^{g}	80.95 ± 2.80^{gh}	96.47 ± 3.34^{g}	53.42 ± 1.85^{e}
Sipiya	23.23 ± 1.84^{g}	34.04 ± 2.70^{fg}	39.79 ± 1.05^{f}	101.76 ± 8.08^{e}	117.86 ± 9.35^{ef}	63.33 ± 5.03^{d}
Sukul	16.96 ± 1.34^{i}	24.18 ± 0.48^{h}	25.27 ± 1.01^{i}	66.317 ± 1.33^{i}	75.00 ± 1.50^{h}	41.55 ± 0.83^{f}
Zardalu	32.45 ± 0.86^{b}	63.10 ± 1.67^{a}	77.59 ± 4.03^{a}	144.67 ± 3.83^{b}	209.00 ± 5.53^{a}	105.36 ± 2.79^{a}
Mean	25.32 ± 1.08^{5}	41.99 ± 1.56^{4}	46.91 ± 1.87^{3}	111.70 ± 4.53^{2}	145.80 ± 88.41^{1}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

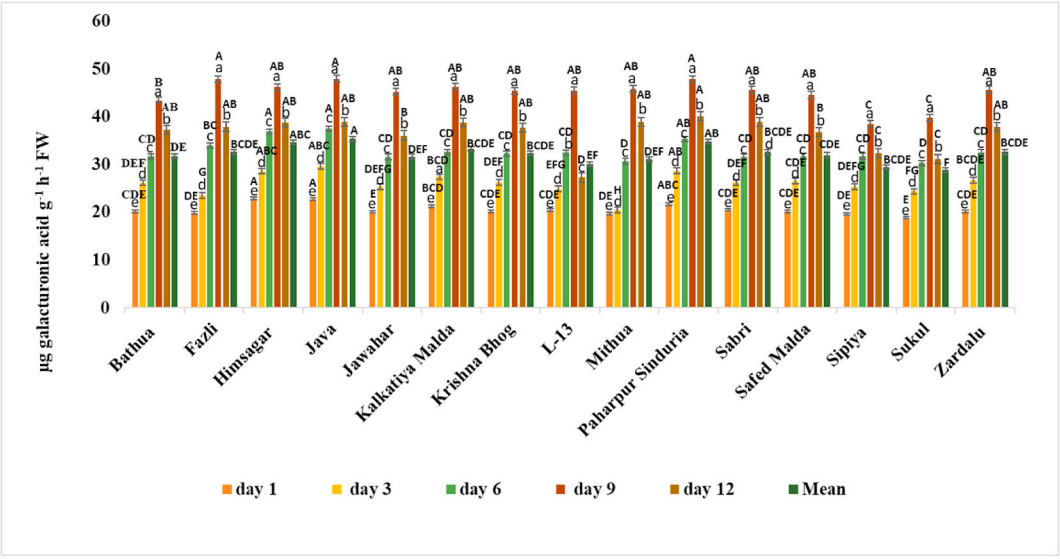

Fig. 1. Polygalactouronase activity of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH). Note: Different capital letters superscript shows significant differences among genotypes whereas, different small letters superscript shows significant differences among storage days.

climacteric phenomenon of mango fruit [29]. Sharma et al. [30] reported variations in the rate of respiration among different genotypes of kiwi. The results of Saroj et al. [21] also support the findings of this research. They observed considerable differences among the selected 20 mango genotypes. Genotypes with higher respiration rates generally exhibit lesser shelf life [31].

3.4.2. Physiological loss in weight (PLW) and storage life

The PLW is one of the important attributes that determine the storage life of fruits. The PLW was recorded the highest in 'Java' (15.57 %) whereas, 'Sukul' (6.63 %) and 'Sipiya' (7.70 %) recorded the lower PLW. The PLW increased throughout the storage period. The higher PLW of mango genotypes might be due to lesser peel thickness which causes higher moisture loss, respiration rate and transpiration rate in fruits [14,32]. The highest storage life was observed in 'Sipiya' (9–11 days) and 'Sukul' and 'Krishna Bhog' (9–12 days) (Table 7).

3.5. Sensory score

Genotypes, storage interval (days) and the interaction (genotype x storage days) significantly influenced the sensory score of mango

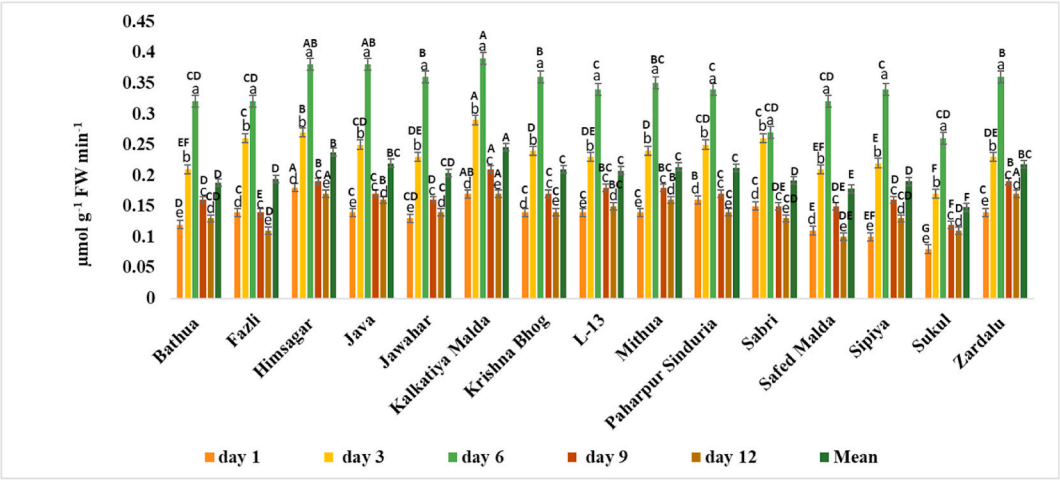

Fig. 2. Pectin methylesterase activity of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH). Note: Different capital letters superscript shows significant differences among genotypes whereas, different small letters superscript shows significant differences among storage days.

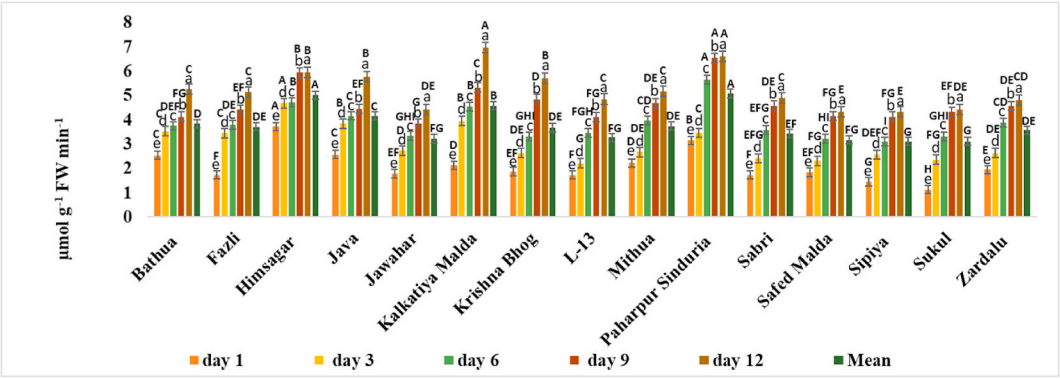

Fig. 3. Lipoxygenase activity of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH). Note: Different capital letters superscript shows significant differences among genotypes whereas, different small letters superscript shows significant differences among storage days.

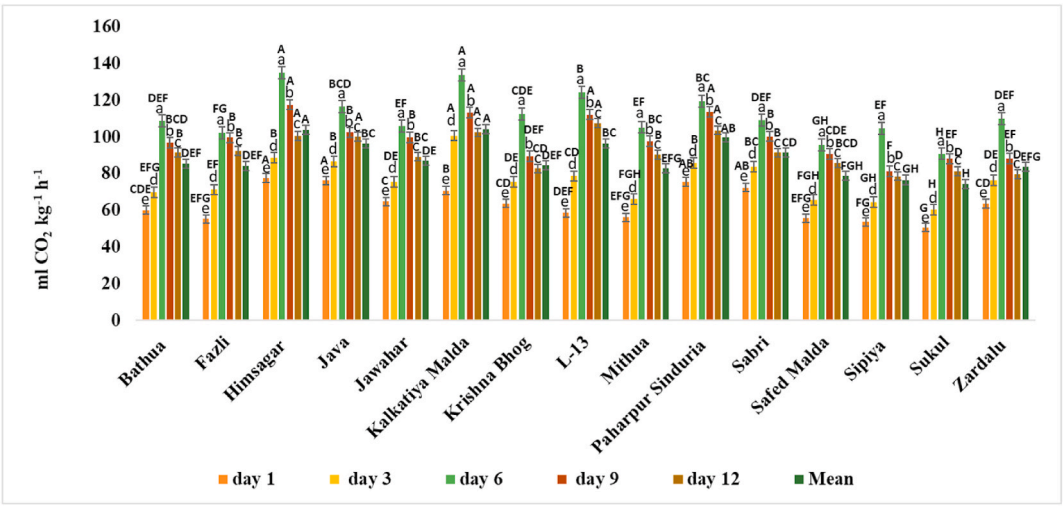

Fig. 4. The respiration rate of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH). Note: Different capital letters superscript shows significant differences among genotypes whereas, different small letters superscript shows significant differences among storage days.

fruits. The overall acceptability value was the highest in 'Safed Malda' (8.08) while the lowest in 'Java' (6.54) and 'Paharpur Sinduria' (6.66) (Table 8). The overall acceptability values increased initially up to the 6th day of storage then decreased and reached the lowest value on the 12th day of storage. The decrease in sensory score with the increase in progress in storage days might be due to a decline in external (colour, texture *etc.*) and internal (TSS, carotenoids and flavonoids) quality attributes of fruit [6,31]. The fruit with the higher sensory score is preferable in the market [4].

3.6. External attributes

The attributes such as fruit weight (g), peel thickness (mm), fruit morphology (shape), and dry seed weight (g) differed significantly among different genotypes of mango. The fruit weight was found the highest in 'Fazli' (404.67 g) whereas, the lower weight was observed in Bathua (147.37 g), 'Sabri' (148 g) and 'Paharpur Sinduria' (151 g). The higher peel thickness was recorded in 'Sukul' (1.89 mm) and Mithua' (1.87 mm) while the lower was recorded in 'Java' (0.64 mm), 'L-13' (0.67 mm) 'Paharpur Sinduria' (0.71 mm) and 'Himsagar' (0.74 mm). Similarly, the highest dry seed weight was found in 'Fazli' (27.23 g) while the lowest was in 'Bathua' (12.13 g). Different genotypes of mango exhibited a significant variation of fruit shapes (Table 9).

One of the most important parameters for determining the acceptability of fruits by the consumer is fruit firmness. Fruit freshness is greatly influenced by fruit firmness. Fruits with higher firmness are usually considered to have better storage life during storage [21]. Irrespective of storage days, the highest fruit firmness was recorded in 'Sipiya' (11.97 N) while the lowest was in 'Paharpur Sinduria' (4.05 N) (Table 10). Irrespective of genotypes, the fruit firmness decreased with progress in the storage period which might be due to an increase in moisture loss and lower membrane integrity [32]. Our findings got the support of Kumar et al. [20] and Megha et al. [3]

Table 7
Physiological loss in weight (%) and storage life of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	3	6	9	12	Mean	Shelf life (days)
Bathua	5.80 ± 0.23^{de}	10.70 ± 0.43^{b}	19.50 ± 0.78^{a}	22.70 ± 0.91^{cd}	14.68 ± 0.29^{bc}	3–6
Fazli	5.00 ± 0.20^{g}	8.60 ± 0.34^{e}	10.10 ± 0.40^{gh}	20.60 ± 0.82^{ef}	11.08 ± 0.29^{f}	6–9
Himsagar	6.10 ± 0.32^{cd}	8.30 ± 0.43^{e}	11.30 ± 0.59^{ef}	19.40 ± 1.01^{f}	11.28 ± 0.45^{f}	6–9
Java	6.30 ± 0.17^{bc}	12.10 ± 0.32^{a}	18.30 ± 0.48^{b}	26.30 ± 0.70^{a}	15.75 ± 0.55^{a}	3–6
Jawahar	5.60 ± 0.44^{ef}	9.50 ± 0.75^{cd}	20.40 ± 1.62^{a}	26.60 ± 2.11^{a}	15.53 ± 1.23^{ab}	6–9
Kalkatiya Malda	6.50 ± 0.52^{bc}	8.90 ± 0.71^{de}	12.40 ± 0.98^{e}	21.50 ± 1.71^{de}	12.33 ± 0.25^{e}	6–9
Krishna Bhog	5.30 ± 0.28^{fg}	8.50 ± 0.44^{e}	9.70 ± 0.50^{gh}	11.50 ± 0.60^{g}	8.75 ± 0.23^{g}	9–12
L-13	5.40 ± 0.11^{fg}	10.80 ± 0.22^{b}	16.10 ± 0.32^{c}	23.60 ± 0.47^{c}	13.98 ± 0.56^{cd}	3–6
Mithua	6.70 ± 0.18^{ab}	8.70 ± 0.23^{e}	15.80 ± 0.42^{cd}	26.80 ± 0.71^{a}	14.50 ± 0.75^{bc}	7–8
Paharpur Sinduria	7.00 ± 0.28^{a}	10.10 ± 0.40^{bc}	20.10 ± 0.80^{a}	22.40 ± 0.90^{cd}	14.90 ± 0.60^{abc}	4–5
Sabri	5.50 ± 0.19^{ef}	10.10 ± 0.35^{bc}	20.20 ± 0.70^{a}	25.40 ± 0.88^{ab}	15.30 ± 0.80^{ab}	4–5
Safed Malda	5.00 ± 0.13^{g}	9.50 ± 0.25^{cd}	10.50 ± 0.28^{fg}	19.20 ± 0.51^{f}	11.05 ± 0.38^{f}	7–8
Sipiya	4.40 ± 0.12^{h}	7.20 ± 0.19^{f}	9.10 ± 0.24^{h}	10.10 ± 0.27^{gh}	7.70 ± 0.61^{h}	9–11
Sukul	4.00 ± 0.08^{h}	5.90 ± 0.12^{g}	7.60 ± 0.15^{i}	9.00 ± 0.18^{h}	6.63 ± 0.13^{h}	9–12
Zardalu	5.70 ± 0.15^{def}	8.70 ± 0.23^{e}	14.70 ± 0.39^{d}	24.00 ± 0.63^{bc}	13.28 ± 0.35^{de}	6–8
Mean	5.62 ± 0.22^{4}	9.17 ± 0.36^{3}	14.39 ± 0.62^{2}	20.61 ± 0.82^{1}		

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

Table 8
Sensory evaluation (1–9 Hedonic scale) of selected mango genotypes under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	7.00 ± 0.28^{e}	7.30 ± 0.29^{f}	7.70 ± 0.31^{e}	6.20 ± 0.25^{hij}	5.30 ± 0.21^{d}	6.70 ± 0.13^{de}
Fazli	7.90 ± 0.32^{abc}	8.40 ± 0.34^{abc}	8.80 ± 0.35^{ab}	7.10 ± 0.28^{def}	5.10 ± 0.20^{d}	7.46 ± 0.20^{b}
Himsagar	7.20 ± 0.37^{de}	7.60 ± 0.39^{def}	7.90 ± 0.41^{ce}	6.60 ± 0.34^{fgh}	5.30 ± 0.28^{d}	6.92 ± 0.28^{bcde}
Java	7.30 ± 0.19^{cde}	7.60 ± 0.20^{def}	7.80 ± 0.21^{e}	5.90 ± 0.16^{j}	4.10 ± 0.11^{f}	6.54 ± 0.23^{e}
Jawahar	7.90 ± 0.63^{abc}	8.20 ± 0.65^{bcd}	8.60 ± 0.68^{abcd}	7.40 ± 0.59^{bcd}	4.70 ± 0.37^{e}	7.36 ± 0.58^{bc}
Kalkatiya Malda	8.10 ± 0.64^{ab}	8.50 ± 0.67^{ab}	8.60 ± 0.68^{abc}	6.00 ± 0.48^{ij}	5.10 ± 0.40^{d}	7.26 ± 0.15^{bcd}
Krishna Bhog	7.80 ± 0.41^{abcd}	8.00 ± 0.42^{bcde}	8.30 ± 0.43^{bcde}	7.50 ± 0.39^{bcd}	5.90 ± 0.31^{c}	7.50 ± 0.20^{b}
L-13	7.50 ± 0.15^{bcde}	7.70 ± 0.15^{def}	7.90 ± 0.16^{ce}	6.10 ± 0.12^{hij}	5.40 ± 0.11^{d}	6.92 ± 0.28^{bcde}
Mithua	7.80 ± 0.21^{abcd}	7.90 ± 0.21^{bcdef}	8.20 ± 0.22^{bcde}	7.80 ± 0.21^{ab}	5.10 ± 0.13^{d}	7.36 ± 0.38^{bc}
Paharpur Sinduria	7.20 ± 0.29^{de}	7.60 ± 0.30^{def}	7.80 ± 0.31^{e}	6.50 ± 0.26^{ghi}	4.20 ± 0.17^{f}	6.66 ± 0.27^{e}
Sabri	7.40 ± 0.26^{cde}	7.80 ± 0.27^{cdef}	8.00 ± 0.28^{cde}	6.80 ± 0.24^{efg}	4.00 ± 0.14^{f}	6.80 ± 0.35^{cde}
Safed Malda	8.40 ± 0.22^{a}	8.10 ± 0.21^{bcd}	8.40 ± 0.22^{abcde}	7.70 ± 0.20^{abc}	7.50 ± 0.17^{a}	8.08 ± 0.27^{a}
Sipiya	7.10 ± 0.19^{e}	7.40 ± 0.20^{ef}	7.80 ± 0.21^{e}	7.20 ± 0.19^{cde}	6.20 ± 0.16^{c}	7.14 ± 0.57^{bcde}
Sukul	7.30 ± 0.15^{cde}	8.90 ± 0.18^{a}	9.00 ± 0.18^{a}	8.10 ± 0.16^{a}	7.10 ± 0.12^{b}	8.03 ± 0.16^{a}
Zardalu	7.60 ± 0.20^{bcde}	7.90 ± 0.21^{bcdef}	8.10 ± 0.21^{cde}	6.60 ± 0.17^{fgh}	4.60 ± 0.12^{e}	6.96 ± 0.18^{bcde}
Mean	7.57 ± 0.30^{3}	7.93 ± 0.31^{2}	8.19 ± 0.32^{1}	6.90 ± 0.274	5.17 ± 2.69^{5}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

who reported significant variability for physical attributes among apple and mango cultivars respectively. The physical attributes directly and indirectly affect consumer preference, fruit marketability and loss reduction during transport.

3.7. Mineral contents

3.7.1. Calcium, potassium and phosphorous

The results of mineral contents displayed that calcium, potassium and phosphorous varied significantly among attempted mango genotypes. Potassium is associated with fruit quality, while phosphorous and calcium improve fruit rigidity [33]. The maximum calcium concentration was observed in 'Sipiya' and 'Sukul' (0.40 mg kg^{-1}) whereas, 'Himsagar' observed the least (0.11 mg kg^{-1}). Potassium content was recorded the higher in 'Sukul' (12.64 mg kg^{-1}) and Safed Malda (12.43 mg $kg^{-1)}$ whereas, it was recorded the lowest in 'Sabri' and L-13 (5.60 mg kg^{-1}). Phosphorous content was observed the highest in 'Sukul' (1.79 mg kg^{-1}) while the lower was observed in 'L-13' (0.91 mg kg^{-1}), 'Paharpur Sinduria' (1.01 mg kg^{-1}) and 'Himsagar' (1.04 mg kg^{-1}) (Table 11). The significant variation in mineral concentration might be due to the genetic variations that exist among mango genotypes. This study got the support of Drozdz et al. [17] who observed variations in minor minerals among wild and cultivated blueberry genotypes. Farina et al. [5] reported varietal diversity for mineral content in papaya and mango genotypes. The genotypes having higher mineral content bear higher nutrient quality and better storage-life properties [20].

Table 9
External attributes of selected mango genotypes at peak ripe stage under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Attributes			
	Fruit weight (g)	Peel thickness (mm)	Seed weight (g)	Fruit shape
Bathua	147.37 ± 20.17^{e}	1.04 ± 0.06^{cd}	12.13 ± 6.50^{g}	Oblong-oval
Fazli	404.67 ± 6.96^{a}	1.85 ± 0.02^{a}	27.23 ± 14.11^{a}	Long-oval
Himsagar	155.23 ± 17.98^{de}	0.74 ± 0.06^{f}	17.83 ±0 .30^{cdef}	Ovate
Java	228.77 ± 6.64^{bcde}	0.64 ± 0.04^{f}	21.67 ± 10.90^{bc}	Oblong
Jawahar	195.37 ± 6.87^{cde}	1.04 ± 0.04^{cd}	16.10 ± 8.10^{defg}	Oblong
Kalkatiya Malda	278.43 ± 14.99^{bc}	1.63 ± 0.02^{b}	17.73 ± 9.40^{cdef}	Oblong
Krishna Bhog	266.20 ± 21.42^{bc}	1.10 ± 0.13^{c}	16.70 ± 8.49^{defg}	Round
L-13	190.67 ± 12.42^{cde}	0.67 ± 0.01^{f}	13.63 ± 6.92^{fg}	Oblong
Mithua	305.57 ± 172.27^{b}	1.87 ± 0.06^{a}	24.90 ± 12.89^{ab}	Long-oval
Paharpur Sinduria	151.10 ± 5.19^{e}	0.71 ± 0.04^{f}	20.30 ± 10.42^{bcd}	Ovoid
Sabri	148.00 ± 18.72^{e}	0.95 ± 0.02^{d}	14.37 ± 7.21^{efg}	Elliptical
Safed Malda	244.00 ± 22.03^{bcd}	1.08 ± 0.03c	19.00 ± 9.56^{cde}	Round
Sipiya	201.20 ± 4.26^{cde}	0.85 ± 0.08^{e}	24.30 ± 12.20^{ab}	Ovate- oblong
Sukul	309.47 ± 36.40^{b}	1.89 ± 0.01^{a}	20.30 ± 10.27^{bcd}	Ovate-oblong
Zardalu	243.57 ± 20.91^{bcd}	1.11 ± 0.07^{c}	15.17 ± 7.59^{efg}	Oblong-obliquely oblong

Note: Values within the column followed by the different superscript letter are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

Table 10
External attributes (fruit firmness) (N) of selected mango genotypes during ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Storage interval (days)					
	0	3	6	9	12	Mean
Bathua	7.33 ± 0.29^{e}	6.37 ± 0.25^{fg}	5.32 ± 0.21^{g}	4.97 ± 0.20^{d}	4.31 ± 0.17^{d}	5.660 ± 0.11^{e}
Fazli	7.10 ± 0.28^{ef}	6.73 ± 0.27^{efg}	5.72 ± 0.23^{efg}	3.44 ± 0.14^{ghi}	3.24 ± 0.13^{fgh}	5.246 ± 0.14^{ef}
Himsagar	6.69 ± 0.35^{f}	6.37 ± 0.33^{fg}	4.13 ± 0.21^{i}	3.75 ± 0.19^{fg}	3.45 ± 0.18^{fg}	4.878 ± 0.20^{fg}
Java	7.33 ± 0.19^{e}	6.29 ± 0.17^{fg}	4.64 ± 0.12^{h}	3.64 ± 0.10^{fgh}	3.45 ± 0.09^{fg}	5.070 ± 0.18^{efg}
Jawahar	7.32 ± 0.58^{e}	6.82 ± 0.54^{e}	6.14 ± 0.49^{e}	4.26 ± 0.34^{e}	3.41 ± 0.27^{fgh}	5.590 ± 0.44^{e}
Kalkatiya Malda	6.89 ± 0.55^{ef}	6.62 ± 0.53^{fg}	4.32 ± 0.34^{hi}	3.39 ± 0.27^{hi}	3.11 ± 0.25^{h}	4.866 ± 0.10^{fg}
Krishna Bhog	8.23 ± 0.43^{d}	7.25 ± 0.38^{d}	6.87 ± 0.36^{d}	4.64 ± 0.24^{d}	4.12 ± 0.21^{d}	6.222 ± 0.16^{d}
L-13	7.12 ± 0.14^{ef}	6.73 ± 0.13^{efg}	5.51 ± 0.11^{fg}	4.73 ± 0.09^{d}	3.83 ± 0.08^{e}	5.584 ± 0.22^{e}
Mithua	6.88 ± 0.18^{ef}	6.21 ± 0.16^{g}	5.81 ± 0.15^{ef}	3.86 ± 0.10^{f}	3.16 ± 0.08^{gh}	5.184 ± 0.27^{efg}
Paharpur Sinduria	5.18 ± 0.21^{g}	5.12 ± 0.20^{h}	4.63 ± 0.19^{hi}	3.21 ± 0.13^{i}	2.10 ± 0.08^{i}	4.048 ± 0.16^{h}
Sabri	6.71 ± 0.23^{f}	6.28 ± 0.22^{fg}	4.75 ± 0.16^{h}	3.83 ± 0.13^{f}	3.13 ± 0.11^{h}	4.940 ± 0.26^{fg}
Safed Malda	5.71 ± 0.15^{g}	5.13 ± 0.14^{h}	4.54 ± 0.12^{hi}	4.26 ± 0.11^{e}	3.48 ± 0.09^{f}	4.624 ± 0.16^{gh}
Sipiya	13.32 ± 0.35^{a}	13.10 ± 0.35^{a}	12.75 ± 0.34^{a}	11.45 ± 0.30^{a}	9.24 ± 0.24^{a}	11.972 ± 0.95^{a}
Sukul	12.37 ± 0.25^{b}	11.31 ± 0.23^{b}	10.37 ± 0.21^{b}	8.34 ± 0.17^{b}	7.33 ± 0.15^{b}	9.944 ± 0.20^{b}
Zardalu	9.22 ± 0.24^{c}	9.53 ± 0.25^{c}	8.42 ± 0.22^{c}	7.72 ± 0.20^{c}	5.32 ± 0.14^{c}	8.042 ± 0.21^{c}
Mean	7.82 ± 0.28^{1}	7.32 ± 0.27^{2}	6.26 ± 0.23^{3}	5.03 ± 0.18^{4}	4.18 ± 0.13^{5}	

Note: Values within the column and horizontal mean row followed by the different superscript letter and digits respectively are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

3.8. Pearson correlation analysis

In our study, we conducted Pearson correlation analysis to investigate the relationships between various physiological and biochemical attributes during the ripening process of indigenous mango genotypes (Fig. 5). Our findings shed light on significant associations between these attributes, which provide valuable insights into mango ripening dynamics. Firstly, we observed a positive correlation between the physiological loss in weight of the mangoes and several enzymatic activities, specifically polygalacturonase (PG) with a correlation coefficient (r) of 0.50, pectin methylesterase (PME) with an r of 0.42, and lipoxygenase (LOX) with an r of 0.29. Additionally, there was a positive correlation between physiological loss in weight and the respiration rate of the fruit, with an r-value of 0.51. This suggests that as mangoes undergo ripening, these enzymatic activities and respiration rate play a role in the loss of weight, however, the weak positive relationship might be because of other variables such as 'changes in fruit texture' and 'fruit metabolism attributes' which were not included in the present study and can be explored further. Conversely, we observed negative correlations between the physiological loss in weight and several other attributes, including phenol content ($r = -0.44$), antioxidant activity ($r = -0.54$), flavonoid content ($r = -0.45$), sensory evaluation scores ($r = -0.66$) and fruit firmness ($r = 0.68$). These negative correlations imply that the mango fruit experience irreversible enhancement in physiological weight loss during ripening, their phenol content, antioxidant capacity, flavonoid levels, sensory acceptability, and fruit firmness tend to decrease with progress in storage period. This suggests that higher physiological weight loss negatively impacts the overall quality and acceptability of the mango fruit.

There were no significant correlations observed between the total carotenoid content and most of the other parameters, except for phenol and seed weight, which showed a positive correlation with each other (Fig. 5). Specifically, carotenoids were found to be

Table 11
Mineral contents (mg kg^{-1}) of selected mango genotypes at peak ripe stage under ambient storage (25 ± 4 °C, 65 ± 5 % RH).

Genotypes	Mineral contents (mg kg^{-1})		
	Calcium	Potassium	Phosphorous
Bathua	0.18 ± 0.004^{efg}	10.60 ± 0.42^{ef}	1.71 ± 0.07^{abcd}
Fazli	0.20 ± 0.004^{de}	10.30 ± 0.41^{fg}	1.62 ± 0.06^{cde}
Himsagar	0.11 ± 0.004^{h}	11.50 ± 0.23^{bd}	1.04 ± 0.05^{g}
Java	0.14 ± 0.006^{efgh}	10.20 ± 0.27^{fgh}	1.47 ± 0.04^{f}
Jawahar	0.24 ± 0.012^{cd}	9.40 ± 0.75^{hi}	1.57 ± 0.12^{ef}
Kalkatiya Malda	0.15 ± 0.012^{efgh}	12.30 ± 0.98^{abc}	1.67 ± 0.13^{abcde}
Krishna Bhog	0.29 ± 0.012^{bc}	9.60 ± 0.50^{gh}	1.63 ± 0.08^{bcde}
L-13	0.17 ± 0.013^{efgh}	5.60 ± 0.11^{j}	0.91 ± 0.02^{g}
Mithua	0.19 ± 0.004^{def}	12.30 ± 0.33^{ab}	1.59 ± 0.04^{def}
Paharpur Sinduria	0.12 ± 0.002^{gh}	11.20 ± 0.45^{de}	1.01 ± 0.04^{g}
Sabri	0.14 ± 0.011^{efgh}	5.60 ± 0.19^{j}	1.55 ± 0.05^{ef}
Safed Malda	0.13 ± 0.005^{fgh}	12.43 ± 0.33^{a}	1.75 ± 0.05^{abc}
Sipiya	0.40 ± 0.016^{a}	9.70 ± 0.26^{gh}	1.76 ± 0.05^{ab}
Sukul	0.40 ± 0.008^{a}	12.60 ± 0.65^{a}	1.79 ± 0.04^{a}
Zardalu	0.34 ± 0.009^{b}	8.70 ± 0.23^{i}	1.67 ± 0.04^{abcde}

Note: Values within column followed by the different superscript letter are significantly different ($p \leq 0.05$) by the Duncan's multiple range test (DMRT).

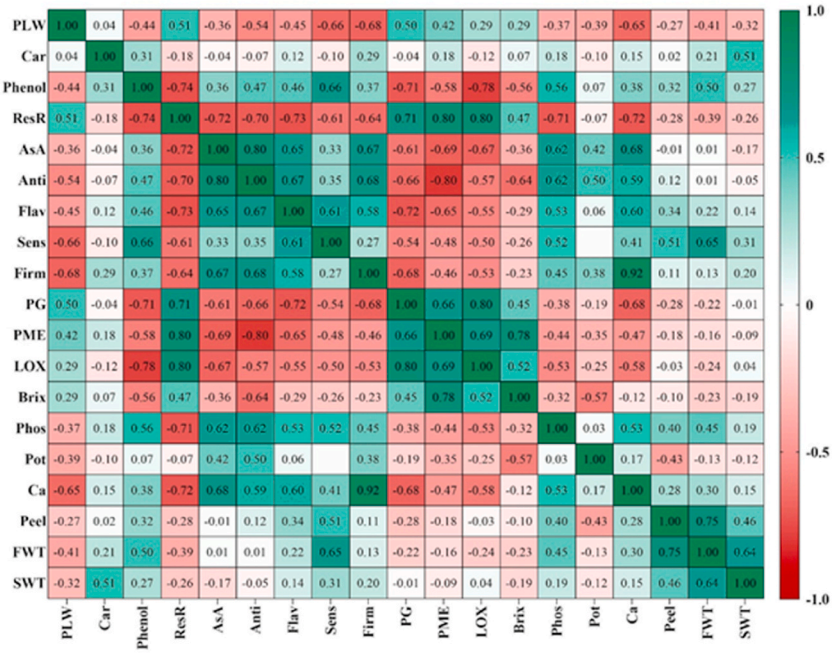

Fig. 5. Pearson's correlation analysis between physical, physiological, and biochemical attributes during the ripening stage of fifteen different genotypes of mango.

positively correlated with phenol levels. This suggests a modest positive relationship between carotenoid content and the activity of the polygalacturonase enzyme, which could potentially impact the color changes observed during ripening. Notably, phenol content exhibited a strong negative correlation of −0.74 with the Respiration Rate (ResR). This strong negative association indicates that mango ripening enhances respiration rate increases, while the phenol content decrease with the progress in storage period. Phenols are known for their antioxidant properties and are often associated with the health benefits and color of fruits. Furthermore, sensory evaluation scores were found to have a robust positive correlation of 0.27 with firmness (Firm). This significant positive relationship suggests that firmness plays a substantial role in influencing the sensory acceptability of mangoes. In general, consumers tend to prefer firmer mangoes in terms of sensory quality [4,21]. In Pearson's correlation matrix, it was observed that the enzymatic activities of PG (polygalacturonase), PME (pectin methylesterase), and LOX (lipoxygenase) displayed significant negative correlations with titrable acidity, ascorbic acid levels, antioxidant activity, flavonoid content, and sensory evaluation. This implies that higher enzymatic activity of these enzymes is associated with lower levels of these attributes in mangoes. Interestingly, peel thickness exhibited a positive correlation with sensory evaluation scores, fresh weight, and seed weight. This suggests that thicker peels are linked to higher sensory

scores, greater fruit weight, and larger seed size.

3.9. Principal Component Analysis (PCA)

Principal Component Analysis (PCA) was employed to illustrate the relationship between the morphological, physiological, and biochemical attributes during the ripening stages of a widely cultivated mango variety (Fig. 6). PCA is a statistical technique that streamlines multiple variables by transforming them into a set of orthogonal variables known as principal components while preserving essential information. In this study, eleven principal components (P1–P11) explained the variance in the data, with the first two principal components accounting for 69.16 % of the total variance. PC1, the first principal component, accounts for a substantial portion of the total variance in the dataset, specifically 57.46 %. This suggests that PC1 summarizes a significant amount of information present in the original variables. It likely represents the most prominent underlying pattern or trend in the data. PC2, the second principal component, has a smaller eigenvalue and accounts for a lower proportion of the total variance, which is 11.70 %. However, when combined with PC1, the cumulative proportion of variance explained by both PC1 and PC2 is 69.16 %. PC2 captures additional, although less substantial, patterns in the data beyond what PC1 already represents. The correlation between variables in pairs or groups indicates a positive correlation, whereas the correlation between variables in opposite directions indicates a negative correlation [21].

4. Conclusions

Based on our findings it can be concluded that the ripening behaviour of most of the studied postharvest attributes exhibited rise with climacteric peak and declined thereafter. However, parameters such as ascorbic acid and total phenolic content declined with progress in storage days, whereas, PLW and LOX enzyme activity increased throughout the storage period. The genotypes such as 'Safed Malda', 'Sukul', 'Sipiya', 'Mithua' and 'Zardalu' exhibited the highest studied biochemical attributes such as TF (493.6–682.4 μg g^{-1}), AAC (16.84–46.88 mg 100 g^{-1} pulp), AOX (2.21–4.84 μmol TE g^{-1}), TCC (5.00–7.30 mg 100 g^{-1}) and sensory score (6.66–8.08). Interestingly 'Sipiya', 'Sukul' and 'Krishna Bhog' exhibited a higher shelf life (4–5 days) as compared to other attempted genotypes. The genotypes having higher nutritional as well as biochemical attributes can be utilized in fruit quality improvement, product making and processing industries. Some genotypes evaluated in this study also bear the potential of a 'Geographical Indications' tag due to the distinct nutritional and quality characteristics and further work can be carried out to explore such possibilities for the benefit of mango growers.

Ethics statement

The experiments were conducted according to established ethical guidelines and informed written consent was obtained from the

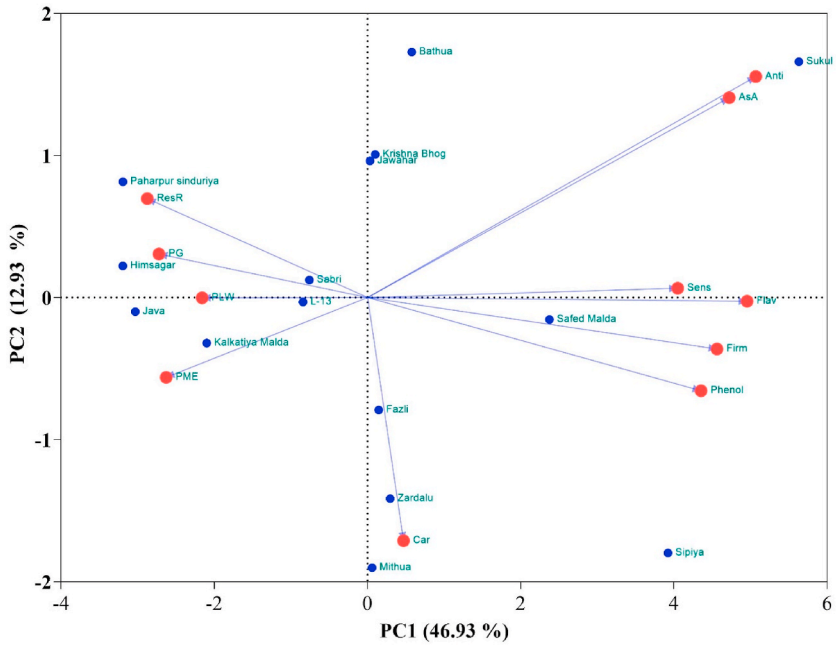

Fig. 6. Principal component analysis: loading plot of PC1 and PC2 describing the variations between physical, physiological, and biochemical attributes during the ripening stage of fifteen different genotypes of mango.

participants. No ethical approvals were required for this study.

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Additional information

No additional information is available for this paper.

Declaration of interest's statement

The authors declare no conflict of interest.

Data availability statement

Data included in this published article, its supplementary material and referenced in the article. No data associated with this study has been deposited into publicly available repository.

CRediT authorship contribution statement

Killi Prasad: Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Neetu Saroj:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Sanjay Kumar Singh:** Resources, Project administration, Investigation, Formal analysis. **Jyostnarani Pradhan:** Resources, Project administration, Investigation, Funding acquisition. **Shiv Shankar Prasad:** Resources, Methodology, Formal analysis. **Sunil Kumar:** Validation, Resources, Methodology, Investigation, Formal analysis. **Shubham Maurya:** Validation, Software, Resources, Methodology. **Alok Kumar:** Validation, Resources, Investigation, Formal analysis. **Rajeev Kumar Srivastava:** Project administration, Investigation, Data curation. **Rahul Kumar Tiwari:** Validation, Software, Resources. **Milan Kumar Lal:** Validation, Software, Resources. **Bhagya Vijayan:** Validation, Supervision, Software, Resources. **Ankit Kumar:** Validation, Software, Methodology, Investigation. **Ipsita Samal:** Validation, Software, Resources, Formal analysis. **Upagya Shah:** Validation, Software, Resources. **Ravinder Kumar:** Writing – review & editing, Validation, Supervision, Software, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper:The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Corresponding authors is associate editor of this journal. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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