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Postharvest quality of Mango (*Mangifera indica* L.) Cv. Pusa Arunima Fruit as affected by different Physico-Chemical Treatments

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ABSTRACT: The present investigation was carried out at Post Harvest Laboratory, Department of Horticulture and Agro processing centre (CoPHT&FP) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut. The experiment "A study on ripening behaviour and post-harvest life of mango (*Mangifera indica* L.) cv. Pusa Arunima" was conducted in a Completely Randomized Design with 12 treatments *viz*., T_0 – Ethrel 500 ppm, T_1-Ethrel 750 ppm, T_2- Ethrel 1000 ppm, T_3- $CaNO_3$ 1.5%, T_4- $CaNO_3$ 2%, T_5-$CaNO_3$ 2.5%, T_6- Egg albumin 5%, T_7-Egg albumin 10%, T_8- Egg albumin 15%, T_9- Pedicellate fruits, T_{10}- $CaNO_3$ 1.5% + Egg albumin 5% and T_{11}- Control and their 3 replications, during the year 2022. The study presents several challenges, with one of the main difficulties ensuring uniformity in applying the various physicochemical treatments to the mango fruits to obtain reliable and comparable results. Additionally, controlling external factors such as temperature and humidity during the postharvest period can be a significant challenge to accurately assess the impact of these treatments on the fruit's quality and shelf life. Out of 12th treatments applied the fruits treated with Ethrel 750 ppm and Ethrel 500 ppm had significantly better fruit quality over other treatments in respect of parameters i.e., Physiological loss in weight, Decay percent, Fruit firmness, Sensory evaluation test, T.S.S., pH, Titrability acidity, reducing sugar. The post-harvest treatment *i.e.*, Pedicellate fruits was found to be next best over other treatments in respect of observations. Based on results obtained from the present study, it can be concluded that Ethrel 500 ppm was found to be the best post-harvest treatment on account of the physical and chemical parameters of Pusa Arunima mango.

Keywords: Titrability acidity, Post-harvest, Mango, Pusa Arunima, Pedicellate fruits, Reducing sugar.

INTRODUCTION

Mango (*Mangifera indica* L.) is known as the 'king of fruits' for its rich taste, flavour, colour, production volume and diverse end usage. It belongs to plant family *Anacardiaceae* and has a small genome size of 439 Mb (2n = 40). Ancient literature indicates origin of cultivated mango in India. Although wild species of genus Mangifera are distributed throughout South and South-East Asia (Singh *et al.*, 2016). The nutrient per 100 gram of edible portion of mango is protein (0.8gm), carbohydrates (15gm), fat 0.4gm), dietary fibre (1.6gm), total sugar (14gm), calcium (6gm), iron (0.16mg), magnesium (10mg), phosphorus (14mg), potassium (168mg), sodium (1mg), vitamin C (36.5mg), thiamine (0.028mg), riboflavin (0.038mg), niacin (0.669mg) (Anonymous, 2018). India has a prominent place in mango production in world followed by China, Thailand, Mexico, Pakistan, Philippines, Indonesia, Brazil, Nigeria and Egypt and accounting for about 50 percent of the total world's mango production. The production of mango in India was 20.38 Metric Million Tonne with a cultivated area of 2.32 million hectares (Anonymous, 2020). In India, Uttar Pradesh has the first rank in mango production and productivity with a share of 23.58 percent in 2021-22. The major mango-growing states in India are Andhra Pradesh, Uttar Pradesh, Karnataka, Bihar, Gujarat, and Telangana. India is also a prominent exporter of fresh mangoes to the world. The country has exported

27,872.78 MT of fresh mangoes to the world for the worth of Rs. 327.45 crore/44.05 USD Millions during the year 2021-22 (APEDA, 2023).

Pusa Arunima, an improved variety of mango, was developed as a hybrid of seed parent 'Amrapali' and pollen parent 'Sensation' at IARI and was released for commercial cultivation to fill the gap of variety-producing fruit with red peel, sweet but not very sweet in taste and pleasant blend of sugar and acid in juice for export. The fruit possesses attractive red coloration on peel with an apricot yellow background on the fruit surface, thick peel, high content of fibreless pulp 70.0 percent, sweet taste T.S.S. 19.5 percent and pleasant blend of sugar and acid in juice. This is a high-yielding variety, which produced mean yield of 40.16 kg high-quality fruits from a tree of 6-20 year bearing age. Fruit juice contained 0.22 percent acidity, 42.3mg of ascorbic acid per 100g pulp and 14,220 micro grams of Beta-caroteneper 100g pulp. Shelf-life of fruit of this variety was 15.3 days at room temperatures and 35 days at low temperature (12ºC) during fruit ripening and storage (Pandey *et al.*, 2014). Finally taking account the mango is climacteric fruit that continue the ripening process after detachment from the parent plant, attributed to the increase in the rate of respiration and ethylene production (Tharanathan *et al.*, 2016), several post-harvest handling process can reduce their post-harvest life and also the fruit composition, leading to losses in term quality and quantity, which can be considerable reduce by applying adequate and improve strategies and technologies to prolong the self-life of mango fruit in India and other tropical countries, the commercial fruit crop is mostly traded in ambient condition and reported to have faster ripening and high post-harvest losses (Singh *et al.*, 2013).

Addressing the major difficulties and challenges under the influence of different physico-chemical treatments requires careful standardization and randomization of the mango samples to ensure consistency and reliability of the results. One of the main challenges was ensuring uniformity among the mangoes used for the different treatments. Mangoes can vary in size and maturity, which could introduce bias into the results. Thus, careful randomization and selection of mangoes were necessary to obtain reliable data. Managing the various treatments was another difficulty. Each treatment required specific conditions and treatments, such as different concentrations of Ethrel, $CaNO_3$, and Egg albumin. This demanded precise execution and monitoring to avoid unintentional variations in the results. Monitoring the ripening process and post-harvest life of mangoes was also labor-intensive and time-consuming. Regular assessment of various quality parameters, such as firmness, color, weight loss, and sugar content, was necessary for each treatment. Environmental factors, such as temperature and humidity, could also impact the outcomes of the study. Maintaining consistent environmental conditions for all treatments was crucial to obtaining accurate results. Finally, the study's scope and resources might have limited the number of samples and replications, potentially affecting the statistical power and reliability of the findings. Despite these challenges, addressing the ripening behavior and post-harvest characteristics of mangoes is essential for the fruit industry and consumers. The study's outcomes can lead to improved post-harvest handling techniques, extended shelf life, and optimized ripening processes for mangoes, benefiting both producers and consumers. Considering the above facts, the present study was carried out on: we examined the postharvest quality of mango (*Mangifera indica* L.) cv. Pusa Arunima fruit as affected by different physico-chemical treatments.

MATERIAL AND METHODS

The present investigation entitled "A study on ripening behaviour and post-harvest life of mango (*Mangifera indica* L.) cv. Pusa Arunima" was carried out at the Postharvest lab, College of Horticulture, and Agro processing centre (CoPHT&FP) of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut U.P. India, during the year 2022. Geographically, the Meerut is situated between 29º04 North latitude, 77°42 East longitude and at an altitude of 237.75 meters above the mean sea level. The variety Pusa Arunima was selected for the study and periodically observed. Planting is done at the distance of 4 × 4 m during 2015 and uniform cultural practices were provided for all varieties. Observation taken during the period of storage, Physiological loss in weight (PLW), Decay percentage, Fruit firmness, Sensory analysis, Total Soluble Solid (TSS), pH of Mango pulp, Total titratable acidity percentage and Reducing sugar. The trial was laid out in a Complete Randomized Design (CRD) and the number of treatments was 12, each replicated thrice. The present observations were carried out at 5th, 10th and fifteenth day during storage. Physiological loss in weight (PLW) was calculated manually during the trial period and its value was calculated by using a formula which was given by Srivastava and Tandon (1968). Data on the Decay/spoilage were recorded during storage and expressed as percentages based on the appearance of visible symptoms of spoilage and unmarketable. The firmness of mango fruit was measured by penetrometer during the trial period and expressed as Newton. Sensory analysis of fruit for organoleptic taste, flavor, Aroma, Fruit freshness, and marketability for all the samples was done using the Hedonic scale. A panel of eight judges aged 21-60 years was made on their consistency and reliability of judgment. The total soluble solid in fruit juice was determined with the help of hand refractometer (0-32 range) and TSS was recorded in degree Brix. Freshly collected clear juice from each mango treatment was taken separately and the pH pulp was measured using a pH meter. The reducing sugar content was determined using titrimetric procedures, while the total titratable acidity (%) was calculated by titrating the extracted juice with 0.01N NaOH, following the standard method with phenolphthalein as the indicator. Statistical analysis of the data was performed using standard procedure as described by Gomez and Gomez (1996).

RESULTS AND DISCUSSION

The present mango data in Table 1 showed that the physiological loss in weight (PLW) of stored fruits treated with Ethrel 500 ppm was found statistically superior over rest of the treatments with minimum percent physiological loss in weight during 5th, 10thand fifteenth day of the storage (1.91, 4.59, 5.73) respectively followed by Ethrel 750 ppm (3.83, 5.88 and 8.60) and Pedicellate fruits (3.46, 5.71 and 8.99). A similar trend was also observed by Sakhale *et al.* (2006).

No decay percent was recorded in all the treatments on the 5th day after storage, while on 10th day Ethrel 500 ppm and pedicellate fruits remain no decay. On fifteenth day of storage, the minimum decay percentage was recorded in Ethrel 500 ppm and Pedicellate fruits (4 and 5) respectively and the maximum percent of decay were recorded in control (0, 6.50 and 15.33). Similar trend was also observed by Singh *et al.* (2012).

On the fifth day of storage, the treatment with Ethrel 500 ppm was the most effective in retaining fruit firmness, followed by Ethrel 750 ppm and pedicellate fruits (44, 42.67, 41.67) N respectively. By the 10th day of storage, the most effective treatments for preserving fruit firmness were Ethrel 500 ppm, Ethrel 750 ppm and Pedicellate fruits (23, 21, 20.67) N respectively. On the fifteenth day of storage, the treatments with Ethrel 500 ppm, Ethrel 750 ppm and Pedicellate fruits were effective in slowing down the decline in fruit firmness (10, 08, 07) N respectively. In general, the firmness decreases as fruits become more mature and decreases rapidly as they ripe. Each cultivar has specific firmness which is related to its sensory attributes Jarimopas and Kitthawee (2007).

Sensory evaluation test on the 5th day obtained maximum mean 7.84 value when fruit was treated with Ethrel 750 ppm followed by Ethrel 500 ppm and Pedicellate fruits 7.42 and 7.37 respectively, while on 10th and fifteenth day, Sensory evaluation tests were conducted in which Ethrel 500 ppm, Ethrel 750 ppm and Pedicellate fruits obtained highest Sensory evaluation score (8.50, 8.26, 8) and (8.09, 7.91, 7.66) respectively. While the minimum sensory score (5.98 and 6.04) on 5th day of storage were recorded when fruit treated with ($CaNO_3$ 1.5% + Egg albumin 5%) and the control. On the 10th and fifteenth day of storage lowest sensory evaluation scores(6.93, 6.77) and (6.41, 6.62) were obtained by Ethrel 1000 ppm and Control respectively. A similar trend was followed by Gupta *et al.* (2015) in their experiment Ethrel 750 ppm and Ethrel 500 ppm found best sensory evaluation scores.

Table 1: Observations of PLW, Decay percent, Firmness and Sensory of mango cv. Pusa Arunima.

Treatments	Day of storage (at ambient room temperature)											
	Physiological loss in weight (PLW)			Decay percentage			Firmness of mango fruits			Sensory evaluation test		
	5th	10 th	15th	5th	10 th	15th	5th	10 th	15th	5th	10 th	15th
ETHREL 500PPM	1.91	4.59	5.73	0	0	4	44	23	10	7.42	8.5	8.09
ETHREL 750PPM	3.83	5.88	8.6	0	1	5.83	42.67	21	8	7.84	8.26	7.91
ETHREL 1000 PPM	6.84	13.34	17.51	0	4.67	11.17	37	13.33	3	6.95	6.93	6.41
$CaNO_3$ 1.5%	4.16	6.24	9.41	0	5.5	8.33	39.33	19	6.33	6.73	7.39	7.16
$CaNO_3$ 2.0%	4.4	6.34	9.32	0	5.67	8.67	41	18.33	6.33	6.41	7.28	6.91
$CaNO_3$ 2.5%	3.99	6.63	9.92	0	5.67	8.83	39	17.33	5.67	6.17	7.33	6.95
EGG ALBUMIN 5%	4.57	6.87	11.1	0	5.33	8.83	40	19	6.33	6.6	7.48	7.32
EGG ALBUMIN 10%	3.8	5.71	9.51	0	5.83	9.17	38.67	17.67	6	6.51	7.4	7.14
EGG ALBUMIN 15%	4.03	6.12	9.11	0	6	9	39	18.67	6	6.46	7.35	7.11
PEDICELLATE FRUITS (15 MM IN LENGTH)	3.46	5.71	8.99	0	0	5	41.67	20.67	7	7.37	8	7.66
$CaNO_3$ 1.5% + EGG ALBUMIN 5%	4.1	6.74	10.99	0	5.5	10.83	39	17.33	5.67	5.98	7.22	6.89
CONTROL	5.13	12.25	16.79	0	6.5	15.33	38	15.67	4.67	6.04	6.77	6.62
Mean	4.18	7.2	10.58	0	4.31	8.75	39.94	18.42	6.25			
SE(m) ±	0.247	0.235	0.298		0.407	0.411	0.681	0.613	0.379			
C.D. at 5%	0.73	0.694	0.879		1.202	1.212	2.01	1.811	1.12			
C.V. (%)	10.23	5.65	4.87		16.38	8.13	2.95	5.77	10.51			

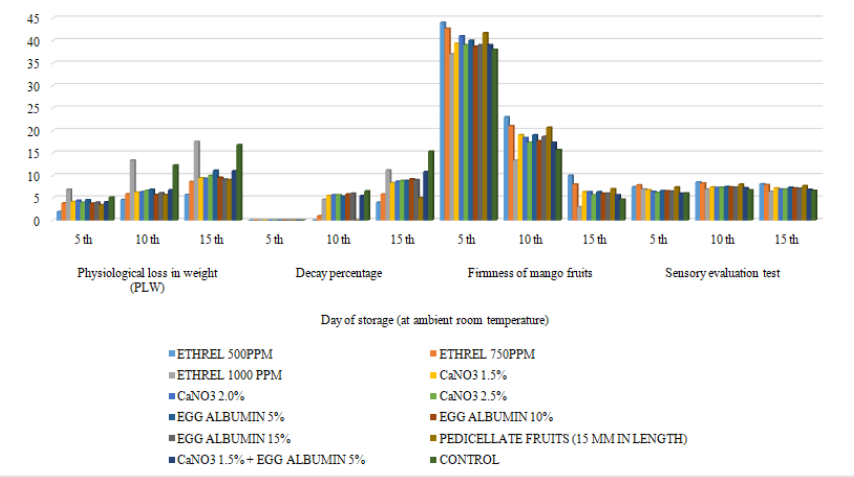

Fig. 1. Observations of PLW, Decay percent, Firmness and Sensory of mango cv. Pusa Arunima.

The present mango data in Table 2. Showed, there was a gradual increase in TSS from the 5th to the 10th day of storage, followed by a notable decline. The fruits treated with Ethrel 750 ppm consistently exhibited statistically superior results over the other treatments, showing the highest TSS levels on the 5th, 10th, and fifteenth day of storage (20, 21.50 and 19) ºBrix respectively. Ethrel 500 ppm (19, 20.33 and 18.50) ºBrix and Pedicellate fruits (17.50, 19.33 and16.67) ºBrix also performed well, yielding superior TSS levels on the respective days. Similar trend was also observed by Singh *et al.* (2012) reported that the maximum TSS were recorded when mango fruits were treated with Ethrel 750 ppm followed by Ethrel 500 ppm in entire experiment.

The reducing sugar of mango was recorded on the 5th day of storage, Pedicellate fruit, Egg albumin 10% and Control were found to minimum reducing sugar (2.62, 2.64 and 2.64) while on 10th day of storage $CaNO_3$ 2.5%, Control and Pedicellate fruits found minimum reducing sugar (3.88, 3.90 and 3.91) respectively. On fifteenth day of storage the lowest reducing sugar (3.76, 3.78 and 3.80)were recorded when fruit were treated with $CaNO_3$ 2.5%, Egg albumin 10% and ($CaNO_3$ 1.5% + Egg albumin 5%) respectively. It might be caused by the hydrolysis of stored starch which releases sugars during mango fruit ripening. It was caused by the increased respiration rate and sugar content that resulted from the oxidation of carbohydrates.

On the 5th day of storage, the fruits treated with Ethrel 1000 ppm exhibited higher pH (4.02) values compared to other treatments, followed by Ethrel 750 ppm (4.01). The treatments with Ethrel 500 ppm and $CaNO_3$ 2% resulted in the lowest pH values on the 5th day (3.83 and 3.92) respectively. On the 10th day of storage, the maximum pH values were observed when fruits were treated with Ethrel 750 ppm and Ethrel 500 ppm, (6.27 and 6.07) respectively. During the fifteenth day of storage, the maximum pH values were recorded when fruit was treated with Pedicellate fruits (6.39), followed by $CaNO_3$ 2% (6.33). The pH increased and the titrable acidity decreased significantly along with increased storage time in both treated and untreated fruits. These results agreed with those reported by El-Ghaouth *et al.* (1991). The increase in pH may be due to the breakup of acids with respiration during storage Pesis *et al.* (1999).

On the 5th day of storage, the treatments with Ethrel 1000 ppm, Ethrel 500 ppm, and Egg albumin 15% resulted in higher titrable acidity levels (0.740, 0.710 and 0.710) respectively. Conversely, the Control, Ethrel 750 ppm and Pedicellate Fruits treatments exhibited the lowest titrable acidity levels (0.613, 0.637, 0.647) on the 5th day of storage. On the 10th day of storage, the highest titrable acidity levels were observed in the Ethrel 1000 ppm treatment (0.280), followed by the Control treatment (0.273). The lowest titrable acidity (2.13) levels were recorded in the Egg albumin 15% treatment, followed by the Ethrel 750 ppm and Egg albumin 5% treatment (0.220) both. Moving on to the fifteenth day of storage, the treatments with Ethrel 750 ppm and ($CaNO_3$ 1.5% + Egg albumin 5%) resulted in the lowest titrable acidity levels 0.160 both followed by Control (0.163) Overall, the best treatment for titrable acidity percentage throughout the study was found to be Ethrel 750 ppm. The decrease in acidity was attributed towards the conversion of citric acid into sugars, which was further utilized by fruit in its metabolic process Lee *et al.* (2010); Baloch and Bibi (2012); Ellong *et al.* (2015).

The higher reducing sugar was recorded when the fruits were treated with Ethrel 750 ppm (3.22, 5.24 and 5.17) on 5th, 10th and fifteenth day of storage respectively. The other effective treatment was Ethrel 1000 ppm (3.04, 4.95 and 4.79) and Ethrel 500 ppm (2.98, 4.93 and 4.88). On10th and fifteenth day of storage the minimum reducing sugar were recorded when fruit treated with $CaNO_3$ 2.5% (3.88 and 3.76) respectively. It can also be observed that reducing sugars and total sugar content of were reduced in the later period of storage. This may be due to their rapid utilization in respiration Hatton *et al.* (1957).

Table 2: Observations of TSS, pH, Titrability acidity and Reducing sugar of mango cv. Pusa Arunima.

Treatments	Day of storage (at ambient room temperature)											
	TSS (ºBrix)			pH of mango fruits			Titrability acidity percentage			Reducing sugar of mango fruits		
	5th	10 th	15th	5th	10 th	15th	5th	10 th	15th	5th	10 th	15th
ETHREL 500PPM	19	20.33	18.5	3.83	6.07	5.89	0.71	0.26	0.183	2.98	4.93	4.88
ETHREL 750PPM	20	21.5	19	4.01	6.27	6.1	0.637	0.22	0.16	3.22	5.24	5.17
ETHREL 1000 PPM	18.5	18.83	16.37	4.02	6	5.95	0.74	0.28	0.2	3.04	4.95	4.79
$CaNO_3$ 1.5%	16	17.8	15.87	3.93	5.9	5.95	0.69	0.247	0.167	2.8	4.2	4.12
$CaNO_3$ 2.0%	16	17.77	16	3.92	5.99	6.33	0.7	0.237	0.173	2.81	4.7	4.58
$CaNO_3$ 2.5%	16.17	17.33	16.5	3.92	5.97	5.94	0.697	0.223	0.167	2.71	3.88	3.76
EGG ALBUMIN 5%	16.43	17.77	16.53	3.96	5.96	6.05	0.7	0.22	0.173	2.79	4.01	3.9
EGG ALBUMIN 10%	16.17	17.47	16.4	3.93	5.97	6.25	0.69	0.227	0.167	2.64	3.92	3.78
EGG ALBUMIN 15%	16	17.73	16.6	3.96	5.99	6.32	0.71	0.213	0.173	2.67	3.95	3.84
PEDICELLATE FRUITS (15 MM IN LENGTH)	17.5	19.33	16.67	3.95	6	6.39	0.647	0.24	0.18	2.62	3.91	3.81
$CaNO_3$ 1.5% + EGG ALBUMIN 5%	15.5	17.07	15.6	3.97	5.94	5.99	0.707	0.23	0.16	2.75	3.92	3.8
CONTROL	15.33	16.83	15.73	3.99	6.01	6.05	0.613	0.273	0.163	2.64	3.9	3.8
Mean	16.88	18.31	16.65	3.95	6.01	6.1	0.687	0.239	0.172	2.81	4.29	4.19
SE(m) ±	0.39	0.384	0.406	0.018	0.115	0.203	0.013	0.008	0.005	0.05	0.101	0.102
C.D. at 5%	1.152	1.135	1.197	0.053	N/A	N/A	0.039	0.022	0.016	0.147	0.299	0.301
C.V. (%)	4	3.64	4.22	0.78	3.3	5.76	3.353	5.495	5.388	3.07	4.09	4.22

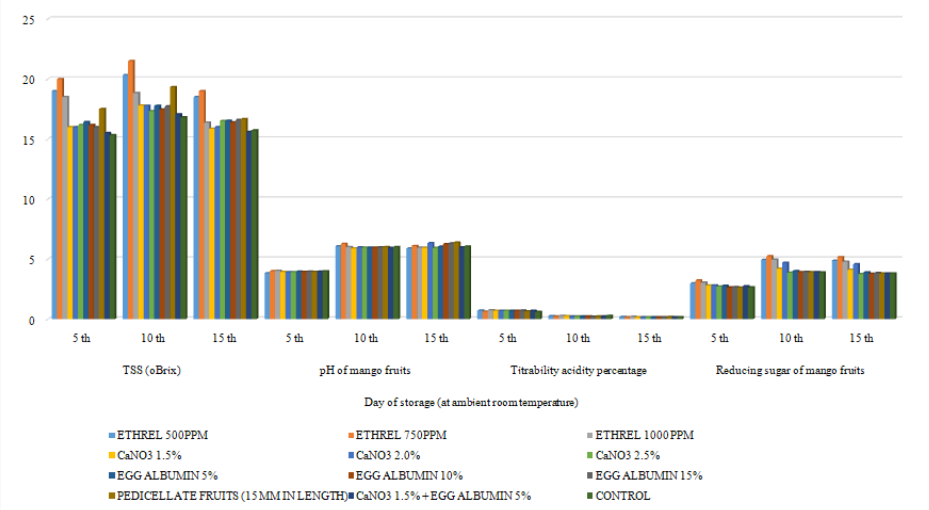

Fig. 2. Observations of TSS, pH, Titrability acidity and Reducing sugars of mango cv. Pusa Arunima.

CONCLUSIONS

Based on the findings of this study, it can be concluded that Ethrel at a concentration of 750 ppm showed the best treatment for the ripening behaviour of mango cv. Pusa Arunima during the 5th, 10th, and fifteenth day of storage, followed by Ethrel 500 ppm was found to be effective. Ethrel at 750 ppm was observed to positively affect the post-harvest quality of mango fruits. Post-harvest life of mango fruits extended when fruit were treated with Ethrel 500 ppm during the storage period.

FUTURE SCOPE

The future prospects of the study hold significant promise for the fruit industry and consumers. The insights gained from this research can pave the way for the development of advanced post-harvest handling techniques and storage methods that can extend the shelf life of mangoes and maintain their quality during transportation. By optimizing the ripening process, it may be possible to offer consumers mangoes with better taste, texture, and nutritional value. Additionally, the findings could potentially lead to the formulation of eco-friendly and sustainable treatments to enhance post-harvest characteristics, reducing food waste and improving overall supply chain efficiency. The study's results could play a crucial role in shaping the mango industry's practices, benefiting growers, exporters, retailers, and consumers by ensuring a more reliable and enjoyable mango experience.

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Conflict of Interest. None.

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