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Impact of pre-harvest treatments on guava fruits under ambient storage conditions

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Abstract

Current research investigation entitled “Impact of pre-harvest treatments on fruit traits stored under ambient conditions in winter guava cv. Allahabad Safeda” was conducted on 7th-year-old trees in the Malwa region of Punjab in collaboration with Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara. The experiment was designed to retain marketability and minimization of quality deterioration by treating the fruits with certain chemicals. The fruits were treated with NAA and salicylic acid each at 100, 200, 300 ppm and ascorbic acid at 75, 150 and 300 ppm. Treated fruits were kept at ambient conditions (during Dec.-Jan.) and tested for quality characters after 3, 6, and 9 days of storage. It can be concluded from present research studies that foliar application of NAA 100 ppm was proved to be the best treatment concerning fruit breadth (5.98 cm) and weight (185.28 g) while the highest palatability (18.94 out of 20) was retained by NAA 200 ppm. Improvement in color development along with maximum fruit firmness (15.11 lbs/cm²) was achieved with SA 200 ppm treatment.

Keywords Guava, Pre-harvest, Chemicals, Ambient storage, Quality

Introduction

Guava (*Psidium guajava* L.) is a tropical/subtropical tree, belonging to the family Myrtaceae. Many pharmacological active constituents are present in guava fruit which can carry several biochemical actions like anti-oxidant, antidiabetic, hepatoprotective, and antimicrobial effects (Kaur *et al.*, 2018). The area under guava cultivation during 2017-18 was recorded as 265,000 ha with an annual production of 4054,000 MT (Anon 2018-19). Maximum production of guava is recorded in Madhya Pradesh (23.8 %) followed by other states like Uttar Pradesh (21.2 %), Bihar (9.26 %), and Maharashtra (6.94 %). Under North zone conditions guava plants flowers thrice in a year. But, its winter crop does not mature properly on trees and fruits remain unripe because of low temperature (Gebru *et al.*, 2015). Plant growth regulators are very useful in improving the Physico-chemical aspects of fruits (Karole and Tiwari 2016). Singh *et al.* (2018) proved that external treatment with various chemicals like PGRs leads to sustain post-harvest fruit quality. PGRs such as NAA, GA₃, CPPU, BAP, and BA are used in fruit crops aiming at the improvement in fruit physiognomies, e.g. to improve shape, color, size, and firmness, to obtain more yields and minimum loss in quality, to lessen the seeds number, and to

prevent post-harvest losses during storage. Singh *et al.* (2017) reported that application with NAA enhances the growth rate, fruit quality and there is no adverse effect on total yield. On the contrary, the high concentration may hamper metabolic activities. PGR's are used to enhance fruit set, internal physiology especially during the development phase, and reduce fruit drop, etc. like disorders (Bons and Kaur, 2020)

Materials and Methods

To study the impact of chemicals on winter guava cv. Allahabad Safeda, the orchard was selected in the Malwa zone of Punjab. Different chemicals were used during the study viz. naphthalene acetic acid and salicylic acid were used each @ 100, 200, and 300 ppm (T₁, T₂, T₃T₄, T₅, and T₆) and ascorbic acid @ 75, 150, 300 ppm (T₇, T₈, and T₉). The first spray of chemicals was given four weeks before harvest. The second spray was applied two weeks before harvest. After harvesting the fruit samples were placed in Corrugated Fiber Board boxes (4 kg capacity and size, 32 X 16 X 16 cm) and kept under ambient storage conditions in December. The fruit samples were taken out from CFB boxes and analyzed for physico-chemical properties after three days

interval viz. 0, 3rd, 6th, and 9th days. The fruit size and weight (gm.) were recorded with the help of Vernier Caliper and weighing balance, respectively. Fruit color was noted by matching the fruits with Royal Horticultural Colour Chart (Wilson 1938), and palatability rating score was recorded out of 20. The fruit firmness was noted with the help of pressure tester 'Penetrometer' after removing skin and in units of lbs/cm. TSS of the fruit was recorded by using a hand refractometer (0-30 % range) and the values were adjusted at 20°C. Acidity, ascorbic acid content, and total sugars of guava fruit were calculated according to A.O.A.C. (2010). The results were interpreted statistically according to a completely randomized block design. The difference between fruit samples was supposed to be statistically significant when $p < 0.05$.

Results and Discussion

Fruit size

Fruit diameter showed a steady and constant decline during ambient storage (Table 1). It was recorded that the fruit diameter was the highest (6.12 cm) in T₁ during the initial storage. As the storage progressed fruit diameter declined after the 3rd day to the tune of 6.07 cm followed by further decreased value of 5.96 cm, 5.75 cm, respectively on the 6th and 9th day with a mean breadth value of 5.98 cm while significantly lower values were obtained in control treatment during the study. However, the interaction was found non-significant between the storage days and treatments. Singh *et al.*, (2017) also obtained the highest fruit size with the application of NAA in guava and reported that enhancement in guava fruit size due to treatment with NAA might be the effect of improved inner physiology during development which encouraged efficient utilization of various resources dynamic compounds.

Fruit weight

The fruit weight of guava continuously decreased with the advancement of the storage period (Table 1). As the storage advanced fruit weight decreased after the 3rd day to the value of 185.72 g followed by further declined value of 184.77 g, 183.93 g on 6th day and 9th day with the highest average weight (185.28 g) in T₅ treatment. The interaction between storage days and treatments was found to be significant during the study. The findings given by Hitesh Kumar (2014) and Singh *et al.* (2017) in the case of red guava also supported current results. Application of NAA prompted cell elongation by the loosening of cell wall and enlargement of vacuoles which ultimately lead to incline fruit weight (Agrawal and Dikshit, 2008) in sapota.

Fruit Firmness

Maximum fruit firmness along with a declining trend (Table 1) was observed in T₄ (15.04 lbs/cm²). On the day of storage firmness of guava fruit was recorded as 16.74 lbs/cm². Corresponding lower values were recorded on

3rd, 6th day and 9th day i.e. 15.10 lbs/cm², 14.50 lbs/cm², 13.82 lbs/cm², respectively. The retention in the firmness of salicylic acid-treated fruits maybe because of the inhibition of cell walls and membrane degrading enzymes such as lipoxygenase, cellulose, and pectin methylesterase and also due to the lesser rate of ethylene production. The results of the current investigation corroborate well with research conducted by Kaur (2016) in guava.

Fruit color

The fruit color changed progressively with the advancement of ambient storage (Table 2). Guava fruits showed various colors from light yellow to yellow-green (YG12A, YG11B, YG10B, GG135B, GG136A, GG135A, YG9B, YG11B, and YG9C) at 0 days of storage. Color changes were very clear as the storage progressed and the best color was obtained in salicylic treatments. On the 3rd day of storage, the fruits were showed light green color (GG 135A, B, and D) but it changed to light yellow-green (YGG145A and B) after 6 days of storage in T₄, T₅, and T₆. On the 9th day of storage, skin color was observed as yellow-green (YGG154B and 154D). However, the fruits in the control treatment were observed light yellow (YGG 154B) on 0 and 3rd days of storage and creamish yellow-orange color (YOG154A) on the 9th day of storage. The change of skin color from green to yellow in fruits is an indication of the fruit ripening process. Salicylic acid was found to be best treated concerning skin color development of the fruit. It may be due to preventing the degradation of chlorophyll and deferring the gathering of carotenoids or gibberellins possibly have senescence postponing action by obstructing ethylene in ber (Selvin 2002). Madhav *et al.*, (2016) also supported the results of the current study that guava fruits treated with salicylic acid resulted in less color change.

Palatability rating

Deterioration in taste and appearance of guava fruits continuously decreased with an increase in storage duration (Table 2). Quality of the fruit is the most important factor from a consumer's point of view, which includes nutritive as well as visual and organoleptic parameters. The highest average value of fruit palatability rating was recorded at the end of the ambient storage period in T₂ treatment with an average value of 18.94. On the 3rd day of storage, it was observed as 19.13 and decreased further during the 6th day and 9th day to the tune of 18.85 and 18.53, respectively. It was followed by T₃ treatment where palatability rating showed a continuous decreasing trend throughout 3rd, 6th, and 9th day with an equivalent value of 18.42, 18.21, and 17.90, respectively. No doubt, the taste of guava fruits during storage improved due to improvement in sugars/acids ratio as results of hydrolysis of starch but appearance also matters due to which less marks were given. The findings of several research workers are in synchronization with the outcome of the current study.

Table 1. Impact of pre-harvest treatments on fruit breadth, weight, and firmness of guava cv. Allahabad Safeda under ambient storage conditions

Treatment	Fruit breadth (cm)					Fruit weight (gm.)					Fruit firmness (lbs/cm ²)				
	0 day	3 rd day	6 th day	9 th day	Mean	0day	3 rd day	6 th day	9 th day	Mean	0 day	3 rd day	6 th day	9 th day	Mean
T1	6.12	6.07	5.96	5.75	5.98	157.59	155.20	153.10	150.37	154.07	16.35	14.29	12.24	12.00	13.72
T2	6.05	5.99	5.87	5.64	5.89	164.73	162.23	159.93	157.83	160.00	16.05	14.00	13.00	12.80	13.96
T3	6.00	5.93	5.80	5.56	5.82	169.79	168.75	167.73	166.73	168.25	16.94	14.85	14.23	14.00	15.01
T4	5.76	5.68	5.54	5.30	5.57	165.49	164.39	163.32	162.27	163.87	17.00	15.78	13.74	13.05	14.89
T5	5.60	5.51	5.35	5.10	5.39	186.70	185.72	184.77	183.93	185.28	16.18	15.31	14.64	14.32	15.11
T6	5.80	5.70	5.54	5.28	5.58	175.78	174.76	173.75	172.80	174.27	16.74	15.10	14.50	13.82	15.04
T7	5.55	5.44	5.27	5.00	5.32	142.90	140.48	138.28	136.08	139.43	16.24	13.30	12.00	11.60	13.29
T8	5.52	5.40	5.22	4.93	5.27	139.30	136.85	134.6	132.37	135.78	16.40	13.00	12.00	11.41	13.2
T9	5.48	5.35	5.16	4.86	5.21	137.25	134.75	132.43	130.16	133.65	16.85	13.58	11.15	11.00	13.15
T10	5.10	4.96	4.76	4.44	4.82	134.95	132.45	130.10	127.81	131.33	16.87	13.35	11.23	11.00	13.11
Mean	5.70	5.60	5.45	5.19	5.48	157.45	155.56	153.80	152.04	154.59	16.56	14.26	12.87	12.50	14.05

C.D.(p≥0.05) **Storage days 0.21 Treatments 0.33 Storage days 0.25 Treatments 0.40 Storage days 0.14 Treatments 0.23**

Singh *et al.*, (2017) obtained the highest mean palatability rating of guava fruits with the application of NAA 300 ppm in storage closely followed by NAA 200 ppm.

Total Soluble Solids

TSS content of the fruit during research investigation varied significantly among treatments. The highest mean total soluble solids (10.91 %) were recorded in T₂ treatment. At 0 day the value of TSS was recorded as 11.67 per cent and it showed reduced values of 3rd, 6th and 9th day as 11.43, 10.70, and 9.83 per cent, respectively but with a declining trend. A reduction in TSS content was observed during ambient storage conditions in all the treatments; however, its content was sustained to an appreciable level irrespective of the treatments. It might be due to the consumption of sugars in the respiration process. The results of current investigations are in agreement with the results submitted by Selvan and Bal (2005) in guava who revealed that TSS continued to decline after storage.

Acidity

Minimum fruit acidity along with a declining trend was observed in T₂ (Table 3) during storage. NAA at 200 ppm treatment has shown minimum acidity mean to the tune of 0.50 per cent with a declining trend. Correspondingly, after 3rd-day the value of acidity was noted as 0.56 percent and it reduced further to 0.44 per cent on the 6th day and 0.32 per cent on the 9th day. Thus, with NAA treatment fruit acidity was lessened which might occur due to early ripening of fruits because of application of the above-mentioned chemical, where acid might have been consumed during the respiration processor promptly

transformed into sugars of various kinds by different reactions involving reverse glycolytic pathways (Agnihotri *et al.* 2013). These results corroborate well with Selvan and Bal (2005) in guava fruits.

Vitamin C

The highest value of vitamin C was recorded immediately after harvesting fruits. A declining trend was noted with the advancement of storage time and declined values were recorded in T₂ treatment at 0 days (234.58 mg/100g), 3rd day (217.99 mg/100g) and declined further during 6th day (201.87 mg/100g) and 9th day (186.79 mg/100g), respectively. At end of the storage period, the average of vitamin C was calculated as 202.22 mg/100g. Various oxidizing enzymes like catalase, ascorbic acid oxidase, polyphenol oxidase, and peroxidase, etc. might be responsible for lessening the ascorbic acid content in the fruit. The results are in line proved by Garasiya *et al.*, (2013) in guava fruits.

Total Sugars

Total sugars increased significantly during ambient storage (Table 3). The slow increase was recorded during the initial stages and thereafter increase was somewhat sharp and again decreasing trend was noted. The highest amount of total sugars were recorded in T₂ treatment having an average value of 7.58 per cent. Initially, total sugars inclined from the value of 0 days (7.45%) to the tune of 7.68% (on 3rd day) from where it showed an increasing trend, 8.03 per cent (6th day) and then again dropped on 9th day i.e. 7.17 per cent. While much lower values were registered in the control treatment (T₁₀, 6.63%).

Table 2. Impact pre-harvest treatments on fruit color, palatability rating, and TSS (%) of guava cv. Allahabad Safeda under ambient storage conditions

Treatment	Fruit Colour				Palatability (Out of 20)					Total soluble solids (%)				
	0 day	3 rd day	6 th day	9 th day	0 day	3 rd day	6 th day	9 th day	Mean	0 day	3 rd day	6 th day	9 th day	Mean
T ₁	YG12A	YG12A	YG13C	YG10C	18.25	17.97	17.64	17.13	17.75	11.67	11.43	10.70	9.83	10.91
T ₂	YG11B	YG11B	YG10C	YG12C	19.23	19.13	18.85	18.53	18.94	11.16	10.94	10.25	9.39	10.44
T ₃	YG10B	YG11B	YG11C	YG12C	18.59	18.42	18.21	17.90	18.28	10.06	9.91	9.26	8.46	9.42
T ₄	GG135 B	GG135B	GG135A	YGG154B	18.19	17.90	17.53	17.00	17.66	10.84	10.66	9.97	9.12	10.15
T ₅	GG136 A	GG135A	YGG145 A	YGG154D	18.49	18.32	18.07	17.76	18.16	10.59	10.42	9.75	8.91	9.92
T ₆	GG135 A	GG135D	YGG145 B	YGG154D	18.62	18.35	18.01	17.60	18.15	9.63	9.50	8.86	8.11	9.03
T ₇	YG9B	YG9B	YG11B	YG11B	17.98	17.69	17.36	16.94	17.49	9.29	9.16	8.54	7.79	8.70
T ₈	YG11B	YG12B	YG13C	YG13D	17.84	17.54	17.19	16.77	17.34	8.44	8.33	7.71	6.96	7.86
T ₉	YG9C	YG10B	YG12B	YG12B	17.79	17.51	17.15	16.68	17.28	8.19	8.10	7.48	6.74	7.63
T ₁₀	YGG15 4B	YGG154B	YG12B	YOG154A	17.71	17.4	17.01	16.54	17.17	10.31	10.15	9.48	8.65	9.65
Mean	---	----	-----	-----	18.27	18.02	17.70	17.29	17.82	10.02	9.86	9.20	8.40	9.37

C.D. (p≥0.05) **Storage days 0.27** **Treatments 0.43** **Storage days 0.10** **Treatments 0.16**

Table 3. Impact of pre-harvest treatments on acidity (%), vitamin C (mg/100 g), and total sugars (%) of guava cv. Allahabad Safeda under ambient storage conditions

Treatment	Acidity (%)					Vitamin C (mg/100 g)					Total sugars (%)				
	0	3 rd	6 th	9 th	Mean	0	3 rd	6 th	9 th	Mean	0	3 rd	6 th	9 th	Mean
T ₁	0.75	0.67	0.58	0.48	0.62	235.51	205.76	191.87	171.00	189.54	7.19	7.38	7.68	6.86	7.28
T ₂	0.67	0.56	0.44	0.32	0.50	234.58	217.99	201.87	186.79	202.22	7.45	7.68	8.03	7.17	7.58
T ₃	0.68	0.57	0.46	0.34	0.51	238.13	218.58	201.58	185.03	201.73	7.30	7.52	7.86	7.01	7.42
T ₄	0.78	0.70	0.62	0.53	0.66	232.45	198.18	180.08	166.97	181.74	7.05	7.20	7.49	6.68	7.11
T ₅	0.70	0.60	0.50	0.39	0.55	233.51	213.05	194.62	177.02	194.90	7.24	7.45	7.77	6.93	7.35
T ₆	0.74	0.65	0.55	0.44	0.60	229.31	208.57	189.07	172.46	190.03	7.21	7.41	7.72	6.89	7.31
T ₇	0.79	0.72	0.65	0.57	0.68	228.61	193.45	172.97	154.76	173.73	6.90	7.70	7.98	7.18	7.44
T ₈	0.85	0.78	0.71	0.63	0.74	233.51	197.08	171.17	151.00	173.08	6.82	6.99	7.26	6.47	6.89
T ₉	0.87	0.81	0.74	0.67	0.77	234.18	197.10	170.94	150.64	172.89	6.79	6.95	7.22	6.44	6.85
T ₁₀	0.91	0.86	0.80	0.73	0.83	235.11	196.00	169.12	149.86	171.66	6.58	6.73	6.98	6.23	6.63
Mean	0.77	0.69	0.61	0.51	0.65	233.49	204.57	184.32	166.55	185.15	7.05	7.30	7.60	6.79	7.18

C.D. (p≥0.05) **Storage days 0.01** **Treatments 0.01** **Storage days 10.72** **Treatments 17.02** **Storage days 0.29** **Treatments 0.38**

This increase was possibly due to dehydration, as in most of the treatments fruits showed high PLW. Singh and Chauhan (1982) also described that the total sugars improved initially up to 2 days of room temperature storage and showed a falling trend with the progression of the storage period. The outcomes of the present study are in harmony with the findings of Iqbal *et al* (2009) and Selvan and Bal (2005) in guava.

Conclusion

Based on present investigations, it can be concluded that guava trees sprayed with NAA 200 ppm proved to be best regarding maintaining fruit breadth (5.98 cm) and TSS (10.91%) while NAA 20 ppm was useful in retaining maximum palatability rating (18.94 out of 20.00), vitamin C (202.22mg/100g) and total sugars (7.58%) and minimum acidity (0.50%).

Salicylic treatment (100-300 ppm) was found suitable for a slow color change but maximum fruit weight and firmness can be achieved with salicylic acid 200 ppm.

Authors' contributions

Jatinder Singh and J.S. Balhave contributed significantly to the conception and design of the study, the interpretation of data, drafting and revision of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors hereby declare no conflict of interest.

Consent for publication

The authors declare that the work has consent for publication.

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