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Effect of Post Harvest Treatments on Physico-Chemical Changes and Marketability during Storage of Guava

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ABSTRACT

Freshly harvested, fully mature green guava fruits of cv. Khaza (Local) were subjected to different post harvest treatments viz., ^{6}N- Benzyl adenine (BA) 50 ppm (T_1), Gibberellic acid (GA3) 50 ppm (T_2), Carnauba wax (CW) 1% (T_3), BA 50 ppm + CW1% (T_4), GA3 50 ppm + CW1% (T_5) and Control (T_6) with 4 replications in Factorial CRD design and stored in ambient condition (Temp: minimum 18^{0}C , maximum 24^{0}C, and RH: 57-84%). Observations were recorded on physiological loss of weight (PLW %), fruit firmness (Kg/cm^2), TSS (^{0}Brix), titratable acidity (%), ascorbic acid (mg/100g), organoleptic quality and fruit marketability. The results indicated that PLW in carnauba wax treatments with or without growth substances remained low throughout the period of storage. Treatment of fruits with benzyl adenine and carnauba wax (BA+CW) i.e., T_4 exhibited least PLW and retained higher firmness, TSS, acidity, ascorbic acid, marketability and organoleptic quality during storage compared to other treatment, this was followed by T_5 (GA_3+CW) and T_3 (CW). In general, firmness and ascorbic acid continuously decreased during storage while TSS, acidity and organoleptic quality increased up to 3rd day of storage; there after it steadily decreased during subsequent period of storage. Organoleptic rating revealed superiority of T_4 and T_5 over other treatments while the control fruits were undesirable on 9th day.

Key words: *Guava, Carnauba Wax, Growth Substances, physico-chemical changes, marketability and Storage.*

INTRODUCTION

Guava (*Psidium guajava* L.) is a delicious and popular fruit. It is widely grown in tropical and sub tropical regions of the country and is considered to be poor man's apple. At present, it ranks fifth among the fruits grown in India occupying 2.55 lakh hectare area with annual production of 4.1 million tonnes[1]. However, the post harvest loss of guava in India is about 25-30% i.e. 4.5 lakh tonnes worth rupees180 crores[2]. The losses are due to undesirable physiological and biochemical changes and infection of disease.

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The fruit is a rich source of Vitamin C and pectin. Guava fruits are climacteric in their respiratory behaviour with ethylene triggering the respiratory rise[3]. It ripens rapidly after harvest and therefore has a short shelf-life. It is a highly perishable fruit and loses its texture and quality in 3-4 days in ambient temperature. Fruit ripening is regulated by hormones. The senescence delaying ability of Gibberellic acid (GA_3) and cytokinins particularly ^{6}N-Benzyladenine (BA) in different fruits and vegetables is well known[4,5]. Carnauba wax is an eco-friendly, edible coating derived from leaves of Brazilian palm tree has prospect of utilization in guava to reduce water loss[6,7]. With this in view of present investigation was undertaken to retain the physico-chemical character and marketability of guava fruits for longer period by post harvest treatment with GA_3, BA and carnauba wax.

MATERIAL AND METHODS

The present study was carried out in the laboratory of Department of Post Harvest Technology of Horticultural Crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, during the period from December 2015 to January 2016. Guava cv. Local (Khaza) were harvested at green mature stage and fruits of specific gravity >1 and free from mechanical damage and blemishes were sorted out. The fruits were then well washed with running tap water to remove the dirt, soil and other foreign matters. After washing, the excess moisture was drained out from the fruits and then dried lightly at room temperature.

Guava fruits after preparation were subjected to different treatment combination of growth substances (GA_3 and BA) and wax emulsion (carnauba wax) for 2 minutes. The treatment consist of T_1 = ^{6}N- benzyl adenine (BA) 50ppm, T_2 = Gibberellic acid (GA_3) 50 ppm, T_3 = Carnauba wax (CW) 1%, T_4= BA 50 ppm + CW1%, T_5 = GA_3 50 ppm + CW1%, T_6 = Control (water), each treatment was replicated four times and each replicate consist of 54 fruits and the experiment was laid out in Factorial Completely Randomized Design. The treated fruits were stored in cool, dry place on racks at room temperature. The maximum and minimum temperature during the period at ambient condition varied from 24^0C and 18^0C respectively and relative humidity from 57 to 84% during the period of storage.

Observations on physiological loss in weight (PLW%), fruit firmness (Kg/cm^2), total soluble solids (^{0}Brix), titratable acidity (%), ascorbic acid (mg/100g), marketability (%) and organoleptic evaluation were recorded at different days interval. Physiological loss in weight was expressed as percentage of the original fresh weights of the fruit. Penetrometer (Model no. FT-327) was used to determine the firmness of the representative sample by puncturing at three different places of fruit (upper, middle and lower portion). Total soluble solid contents was estimated with a hand refractometer (Erma, Japan) and expressed as ^{0}Brix. Titratable acidity was determined as percentage citric acid according to method described in A.O.A.C[8]. Ascorbic acid content of guava pulp samples were determined by 2, 6-dichlorophenol indophenol titration method as described by Ranganna[9]. For marketability number of fruits acceptable by consumer in each treatment on the day of observation was recorded and expressed in percentage. Organoleptic evaluation was recorded on basis of physical characters of fruits viz, fruit appearance (colour), taste, firmness and flavour by a panel of judges as per "hedonic scale" (1-9 point), which is as follows : extremely desirable (MD)=9, very much desirable (VMD)=8, moderately desirable (MD) , slightly desirable (SD)=6 neither desirable (ND) nor undesirable (UD) =5 slightly undesirable (SUD)=4 moderately undesirable (MUD)=3 very much undesirable (VMUD)=2 , and extremely undesirable (EUD)=1[10]. The experiment was laid out in two factor Factorial Completely Randomized Design and data was analyzed by adopting the statistical procedures of Gomez and Gomez[11].

RESULTS AND DISCUSSION

Physiological loss of weight (PLW %) was significantly different for treatment, duration of storage while treatment × duration interaction was non-significant at 5% level (Table 1). Mean PLW of treatment during the period of storage up to 9 days was highest (11.08%) in control and least (9.12%) in T_4 (BA+CW). Irrespective of treatments, mean PLW increased significantly with the enhancement of storage duration from 3.94% on 3rd day to 15.48 on 9th day of storage. It was found that throughout the period of storage PLW was significantly low in T_4 (BA+CW), T_5 (GA_3+CW) and T_3 (CW %). On 9th day of storage the PLW of T_4, T_5 and T_3 was 14.63%, 14.72% and 15.03 % respectively compared to 15.48% in control.

Fruit firmness exhibited significant difference between treatment, storage duration and treatment × storage duration interaction at 5% level (Table 1). Mean firmness of treated fruits on different days of storage decreased with advancement of storage period from 21.46 kg/cm^2 on 3rd day to 8.53 kg/cm^2 on 9th day of storage. Firmness decreased steadily in T_4 (BA+CW), T_5 (GA_3+CW) and T_3 (CW) during storage. Irrespective of storage average firmness of different treatments was recorded to be maximum (18.72 kg/cm^2) in T_4 (BA+CW) followed by 16.81 kg/cm^2 in T_5 (GA_3+CW) , 15.22 kg/cm^2 in T_3 (CW), 14.16 Kg/cm^2 in T_2 (GA_3), 13.47 kg/cm^2 in T_1 (BA) and 10.94 kg/cm^2 in T_6 (control) in that decreasing order. On 9th day of storage firmness of T_4 remained significantly higher than other treatments. Firmness of control fruits decreased abruptly and became as low as 3.58 kg/cm^2 (soft) on 9th day of storage.

TSS was significantly influenced by treatment, storage duration and interaction of treatment × storage duration at 5% level (Table 2). Initial TSS of fruit i.e., on the day of treatment ('0' days of storage) was observed to be 8.51 ^{0}Brix. In all the treatment except T_4 (BA+CW) the TSS increased up to 3rd day and then it gradually decreased up to 9th day of storage. In T_4, TSS increased up to 6th day (though not significant) and then it decreased during subsequent days of storage. In general, mean TSS of different treated stored fruits remained high in T_3 (CW), T_4 (BA+CW) and T_5 (GA_3+CW) i.e., 10.58 ^{0}Brix, 10.36 ^{0}Brix and 10.45 ^{0}Brix respectively with no significant difference between T_3, T_4 and T_5. Irrespective of treatments mean TSS decreased significantly during storage from 3rd (11.43 ^{0}Brix) to 6th day (10.29 ^{0}Brix) and subsequently to 9th day (8.30 ^{0}Brix). On 9th day of storage the TSS of T_4 (BA+CW) was maximum (9.30 ^{0}Brix) followed by T_5 (GA_3+CW), T_3 (CW), T_2 (GA_3), T_1 (BA) and T_6 (control) in that decreasing order.

Acidity had a significant effect for treatment and storage duration but non-significant for treatment × storage interaction at 5% level (Table 2). Initial acidity on the day of post of treatment ('0' days of storage) was recorded to be 0.384%. Acidity increased up to 3rd day in all the treatments then it gradually declined during the subsequently period of storage. Acidity on 9th day of storage was highest (0.41%) in T_4 (BA+CW) followed by T_5 (GA_3+CW), T_3 (CW), T_2 (GA_3), T_1 (BA) and control in that decreasing order. Irrespective of treatments mean acidity of different days of storage decreased significantly from 0.45% on 3rd day to 0.35% on 6th day followed by 0.32% on 9th day. Throughout storage period T_4 (BA+CW) retained higher acidity compared to other treatments and on 9th day maximum acidity (0.37%) was retained by T_4 and T_5 followed by T_3 (0.32%).

Organoleptic evaluation on the basis of appearance (colour), taste, texture and flavour exhibited significant effect for treatment and storage duration but non significant for treatment × storage at 5% level (Table-3). The mean organoleptic score at different storage period recorded high score of 8.31 in T_5 (GA_3+CW) followed by 8.15 in T_4 (BA+CW) and 8.04 in T_3 (CW). However, T_3, T_4 and T_5 were at par and did not differ significantly. Irrespective of treatments, mean organoleptic score decreased significantly from 8.50 on 3rd day to 6.46 on 9th day. 0n 9th day the organoleptic score of T_4 and T_5 was high (7.49)

followed by T_3 (7.03), T_1 (6.79), T_2 (6.18) and T_6 (3.80) respectively showing that T_4 and T_5 and to some extend T_3 maintained higher quality during later period of storage.

Ascorbic acid exhibited significant effect for treatment, storage duration and interaction of treatment × storage duration at 5% level (Table 3). Initial ascorbic acid content of guava fruits on the day of treatment was estimated to be 397.11 mg/100g. Ascorbic acid continuously decreased in all the treatments during storage. Mean ascorbic acid content due to storage was observed to be maximum (342.70 mg/100g) in T_4 (BA+CW) followed by (330.09 mg/100g) in T_5 (GA_3+CW), (325.02 mg/100g) in T_3(CW), (302.08 mg/100g) in T_1 (BA), (281.29 mg/100g) in T_2 (GA_3) and (244.70 mg/100g in T_6 (Control) in that decreased order. However T_3, T_4 and T_5 did not differ significantly with respect to mean ascorbic acid content during storage. Irrespective of treatment, mean ascorbic acid content decreased significantly from 3rd day (355.08 mg/100g) to 6th day (293.27 mg/100g) and then 9th day (264.70 mg/100g) respectively. Throughout the period of storage T_3, T_4 and T_5 retained high ascorbic acid content and on 9th day maximum ascorbic acid content was observed in T_4 (306.76 mg/100gm) followed by T_5 (289.81 mg/100g) and T_3 (298.75 mg/100g) respectively. However there was no significant difference between T_4, T_5 and T_3 with respect to ascorbic acid on 9th day. Control fruit possessed least ascorbic acid content (192.26 mg/100g).

Marketability of different reduced considerably after 6th day of storage. Marketability of controlled fruits was to 22.2% on 9th day of storage while T_4 recorded maximum of 77.7% followed by T_5 (66.6%) and T_3 (66.6%) (Fig1).

The skin-coating plugs the openings of the fruit skin surface, thereby reduces their respiration and transpiration, thus successfully prolonging their storage life and impart better gloss to guava fruits[12,13]. Coating manipulates levels of oxygen and carbon-dioxide within fruits and creates modified atmospheres rich in CO_2, which is known to delay ripening[14]. In the present investigation waxed fruits with or without BA or GA_3 i.e., T_3, T_4 and T_5 have low PLW and retained better fruit firmness than fruits treated with BA and GA_3 only and control fruits which is in conformity with earlier findings with carnauba wax[15,16]. The effect of waxing to retard the firmness loss is due to its role in checking the activity of cell wall enzymes. It might also be attributed to change in the turgor pressure of the cells and changes in the composition of cell wall pectin and lipo pectin membrane bordering the cells[17]. Post harvest use of GA_3 has senescence delaying effect in fruits and vegetables[18,19] suggested that GA_3 @100ppm significantly suppress the succinate activities of malate-dehydrogenase during post-harvest ripening of papaya fruits and thus retarded ripening. Benzyl adenine has been reported to possess free radical quenching property which inhibited ethylene biosynthesis resulting in retardation of senescence and gradual build up of sugars (as in mango)[20]. Softening in fruits is caused either by a breakdown of insoluble pectin or by hydrolysis of starch[21]. In T_4 and T_5 where fruits were treated with GA_3 and BA along with carnauba wax, additive effect due to cumulative action of growth substances and wax emulsion was significantly pronounced as manifested by retardation of senescence by reducing the weight loss, retaining the firmness, TSS, acidity, ascorbic acid and organoleptic quality for a longer period.

The increase in TSS during storage possibly due to starch is converted into sugars as on complete hydrolysis of starch no further increase occurs and subsequently a decline in these parameters is predictable as they along with other organic acids are primary substrate for respiration[22]. The decrease in titratable acidity during ripening and storage may be attributed to an increase in malic enzyme and pyruvate decarboxylation reaction during climacteric period[23]. The decrease in ascorbic acid was caused by oxidation of ascorbic acid in storage[24,25]. Low oxygen created by modified atmosphere causing reduced activities of oxidizing enzymes in wax coated treatments ie., T_3, T_4 and T_5 which might be

the possible reason of higher ascorbic acid content during storage. In the present investigation considering senescence delaying ability with regard to all the quality parameters, T_4 (BA+CW) was found to be the best treatment followed by T_5 (GA_3+CW) and T_3 (CW).

Table 1: Effect of treatments on PLW (%) and Firmness (kg/cm^2) during storage

Treatment	PLW (%)				Firmness (kg/cm^2)			
	Days				Days			
	3rd	6th	9th	Mean	3rd	6th	9th	Mean
T_1 (BA 50ppm)	4.00	10.38	15.85	10.08	19.00 (hard)	14.50 (semi-hard)	6.92 (soft)	13.47
T_2 ($GA_3$50ppm)	4.11	10.54	15.07	9.91	21.50 (hard)	14.33 (semi-hard)	6.67 (soft)	14.16
T_3 (CW1%)	3.77	9.72	15.03	9.51	20.33 (hard)	15.50 (semi- hard)	9.83 (semi-hard)	15.22
T_4 (BA+CW)	3.49	9.23	14.63	9.12	25.58 (semi- hard)	16.67 (semi-hard)	13.92 (semi-hard)	18.72
T_5 (GA_3+CW)	3.65	9.11	14.72	9.16	24.08 (semi-hard)	16.08 (semi-hard)	10.25 (semi-hard)	16.81
T_6 (Control)	4.62	11.07	17.55	11.08	18.25 (hard to semi-hard)	11.00 (Semi- hard to soft)	3.58 (soft)	10.94
Mean	3.94	10.01	15.48	9.81	21.46	14.68	8.53	14.89
	T	S	T × S		T	S	T × S	
S. Em±	0.305	0.216	0.528		0.381	0.269	0.66	
CD at 5%	0.864	0.612	NS		1.08	0.762	1.871	

Table 2: Effect of treatments on TSS (^{0}Brix) and Acidity (%) during storage

Treatment	TSS (^{0}Brix)				Acidity (%)			
	Days				Days			
	3rd	6th	9th	Mean	3rd	6th	9th	Mean
T_1(BA 50ppm)	11.95	9.93	8.13	10.00	0.43	0.33	0.32	0.36
T_2 (GA_3 50ppm)	11.05	10.13	8.25	9.81	0.43	0.34	0.30	0.36
T_3 (CW1%)	11.55	11.05	9.13	10.58	0.44	0.38	0.32	0.38
T_4 (BA+CW)	10.85	10.93	9.30	10.36	0.49	0.38	0.37	0.41
T_5 (GA_3+CW)	11.10	11.05	9.20	10.45	0.45	0.31	0.37	0.38
T_6 (Control)	12.05	8.65	5.80	8.83	0.43	0.35	0.25	0.34
Mean	11.43	10.29	8.30	10.00	0.45	0.35	0.32	0.37
	T	S	T × S		T	S	T × S	
S. Em±	0.175	0.124	0.304		0.012	0.008	0.021	
CD at 5%	0.496	0.351	0.861		0.034	0.022	NS	

Initial TSS (fresh sample) = 8.51 ^{0}Brix
Initial Acidity (fresh sample) = 0.384%

T= Treatment,
S= Storage period

Table 3: Effect of treatments on organoleptic score and Ascorbic acid (mg/100gm) during storage

Treatment	Organoleptic score				Ascorbic acid (mg/100gm)			
	Days				Days			
	3rd	6th	9th	Mean	3rd	6th	9th	Mean
T_1(BA 50ppm)	8.31	7.81	6.79	7.64	349.60	295.63	261.03	302.08
T_2 (GA_3 50ppm)	8.08	7.01	6.18	7.09	327.02	277.85	239.01	281.29
T_3 (CW1%)	8.89	8.21	7.03	8.04	372.55	303.76	298.75	325.02
T_4 (BA+CW)	8.69	8.26	7.49	8.15	383.98	337.43	306.70	342.70
T_5 (GA_3+CW)	8.88	8.56	7.49	8.31	379.00	321.45	289.81	330.09
T_6 (Control)	8.16	6.56	3.80	6.18	318.32	223.51	192.26	244.70
Mean	8.50	7.74	6.46	7.57	355.08	293.27	264.59	304.31
	T	S	T × S		T	S	T × S	
S. Em±	0.264	0.186	0.456		6.478	4.581	11.221	
CD at 5%	0.748	0.527	NS		18.367	12.988	31.815	

Initial organoleptic score ('0' days) = 8.00 NS = non significant

Initial ascorbic acid (fresh sample) = 397.11 mg/100gm NS = non significant

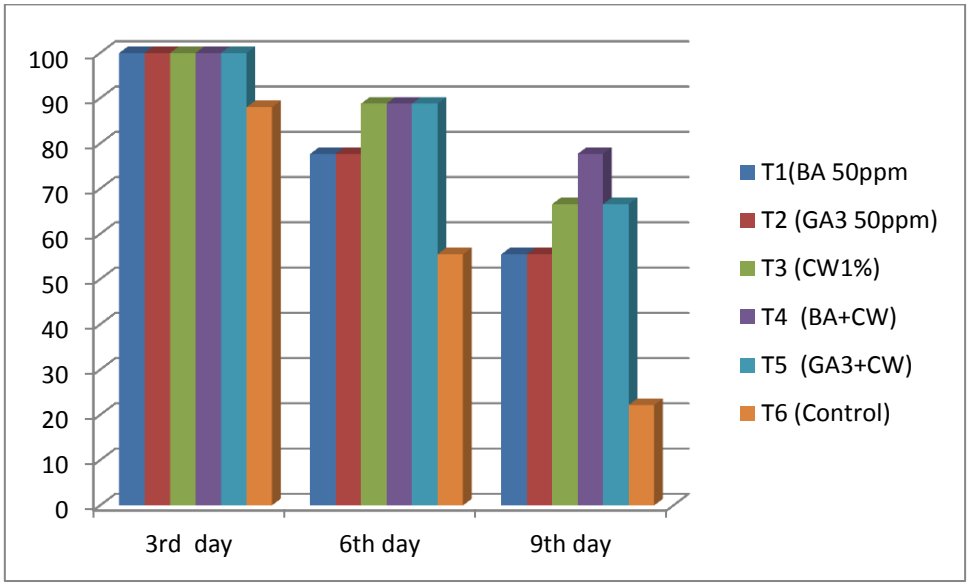

Fig. 1: Marketability of fruits during storage

CONCLUSION

Thus it can be concluded that benzyl adenine 50 ppm with carnauba wax (1%) i.e., T_4 (BA+CW) can be regarded best treatment combination because it exhibited least PLW and retained higher firmness, TSS, acidity, marketability and ascorbic acid content during storage compared to other treatments, this was followed by T_5 (GA_3+CW) and T_3 (CW). Organoleptic quality also revealed superiority of T_4, T_5 and T_3 because of high sensory score over other treatments while the control fruits were undesirable on 9th day due to low score.

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