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ORIGINAL ARTICLE

Postharvest Application of Boric Acid and NAA in Guava to Improve Shelf-life and Maintain Quality under Cold Storage

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ABSTRACT
Guava fruit is thin skinned and highly perishable in nature so suffers great extent of post-harvest loss.Postharvest application of chemicals like GA_3, Salicylic acid, NAA, potassium permanganate and boric acid is commercially acceptable and economically feasible technique to enhance shelf life of guava. The study was carried to compare the efficacy of boric acid and NAA for shelf-life enhancement of guava fruits stored under cold storage.Fruits were treated with Boric acid @ 100ppm (T_1), Boric acid @ 200ppm (T_2), Boric acid @ 300ppm (T_3), NAA @ 200ppm (T_4), NAA @ 300ppm (T_5) and NAA @ 400ppm (T_6) for 1-2 minutes and stored under cold storage. The physical parameters like fruit size, fruit weight and specific gravity; chemical parameters like TSS, titratable acidity and ascorbic acid; and palatability rating were observed and compared with untreated fruits (T_0- control).Both, boric acid and NAA, had significantly affected the shelf life of guava fruits and positive correlation was reported between guava fruit quality and concentration of these chemicals. Boric Acid 200ppm and 300ppm were equally effective, similarly NAA 300ppm and 400 ppm were equally effective for quality retention in guava fruits.Boric acid and NAA (200-300ppm) can be used as postharvest treatment of guava for extending shelf life.
***Keywords**: Ascorbic Acid, Boric Acid,Cold Storage, Guava, NAA, Shelf life*

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INTRODUCTION

Guava(*Psidium guavaja* L.) fruits are excellent source of antioxidant like ascorbic acid, carotenoids, dietary fiber, and polyphenolics. Lycopene is primary carotenoid of guava fruits and provide pink colour to guava flesh. Guava is a highly perishable fruit. The postharvest loss in guava fruits is estimated to be at 3.4-15.1 percent [1].The skin of guava fruits is soft and thin which make these fruits prone to mechanical injuries, insects and pathogens attack so has very short shelf life [2]. Various means of extending the shelf-life of fresh fruits have been experimented and recommended for different kinds of fruits *viz.* low temperature storage, wax coating on skin,pre-harvest and postharvest treatment of fruits with growth regulators and other chemicals, packaging of fruits, use of ethylene absorbent. Since, the response of fruits to these treatments vary with different kinds of fruits and the varieties and the local ambient conditions, it may be necessary to find out a suitable technology for extending the shelf-life of guava fruits.The fruit stored in low temperature storage, using growth regulators/chemicals and processing of fully ripened guava fruits to improve the surplus horticultural produce might be available for future use. Singh *et al*. [3] and Singh [4] found that the post-harvest sprays of various growth regulators like Auxins, Gibberellins, NAA can improve storage life by reducing physiological weight loss, spoilage and delaying of senescence.

Boric acid has been reported to be effective against ethylene production, CO_2 production and disease incidence and reducesrate of respiration and ripening [5]. Goswami *et al*. [6] had observed maximum weight of fruits when treated with 0.4 per cent boric acid and it was at par with zinc sulphate 0.4 per cent. The zinc sulphate 0.4 per cent significantly improves the physicochemical quality, viz., total soluble solids, acidity, ascorbic acid, reducing, non-reducing and total sugar at harvest. The physiological loss in weight

after harvest was minimum under zinc sulphate at 0.4 per cent closely followed by boric acid at 0.4 per cent. Minimum degree of spoilage was also observed with the application of 0.4% zinc sulphate followed by 0.4% boric acid. Duenas [7] had advocated the significance of minimizing the loss in weight of fresh fruit during storage which is a natural response to increased transpiration and respiration[8]. Therefore, the use of good post-harvest handling practices from field to market also become more significant. Thus, the storage of fruits with the use of growth regulators and different packing materials combined with suitable temperatures need special attention.Fruits treated with NAA (100 ppm) maintained highest mean of TSS (9.73%) upto 40 days of storage.The winter crop of guava cv. Sardar when provided with pre-harvestapplication of naphthalene acetic acid (100ppm) and potassium nitrate, harvested at optimum maturity, packed in CFB boxes lined with newspaper and stored at 6- 8^0C and 90-95% RH, effectively reduced spoilage maintained higher fruit firmness, TSS and ascorbic acid and remain slightly desirable after 30days of storage. Thus, pre-harvest spray with NAA (100 ppm) seems to be effective method for decreasing postharvest losses and maintaining quality of guava fruits. The present investigation was carried out with the objective to determine suitable dose of boric acid and NAA as postharvest application in guava to extend shelf life of fruits stored under cold storage.

MATERIALS AND METHODS

The present investigation were carried out at Horticulture Department, School of Agriculture, Lovely Professional University, Punjab, during 2014-15. The guava fruits (Allahabad Safeda) were harvested and collected in polythene bags and taken to the laboratory for analysis.Fruits with uniform size and colour were selected while diseased fruits were discarded. Guava fruits were sorted, destalked and pre cooled in running water for 12-15 minutes.Harvested fruits of guava were dipped in different chemicals with different concentrations like Boric acid @ 100ppm (T_1), Boric acid @ 200ppm (T_2), Boric acid @ 300ppm (T_3), NAA @ 200ppm (T_4), NAA @ 300ppm (T_5) and NAA @ 400ppm (T_6) for 1-2 minutes.After dipping, the fruits were exposed in air for few minutes for drying and then stored at 7^0C -9 ^{0}C with 85 - 90% relative humidity in sealed, perforated polyethylene bags for further studies. Observations were recorded for various physical parameters like average fruit size (Length x Breadth), average fruit weight (g) and specific gravity (g/cc). The juice of randomly selected fruits from each treatment was extracted and was evaluated for the chemical parameters like TSS, titratable acidity and ascorbic acid [9,10]. The observations were analysed for Completely Randomized Design (CRD) and significance of treatments and storage days were evaluated at 5% level of significance.

RESULTS AND DISCUSSION

Effect on physical parameters of guava fruits

The observations recorded on fruit weight, fruit size and specific gravity of guava fruits treated with boric acid or NAA and stored under cold atmosphere have been presented in Figure 1, Figure 2 and Figure 3, respectively. It is clear from the observations that average fruit weight and average fruit size reflected a gradual decrease during different days of storage which might be due to loss of moisture. However, all treatments have been reported to be better in terms of quality retention but impact was non-significant. Specific gravity of guava fruits during different storage days was reported which revealed a gradual increase during initial phase (up to 21 days of storage) while gradual decrease was reported in last phase of cold storage. The decrease in specific gravity could be due to loss of weight and decrease of volume and also due to the conversion of starch into sugar. The fruits treated with Boric acid or NAA shown reduced weight loss and respiration which was helpful in maintaining higher value of specific gravity even during later phase of cold storage. At 35 days of storage, fruit treated with 300ppm of boric acid (T_3) retained highest value (1.02 g/ml) of specific gravity followed by T_1 (1.013 g/ml) and T_2 (1.007 g/ml). The interaction between treatments and storage days was reported non- significant.Application of boric acid or NAA was positive for quality retention is due to their stimulatory effect on plant metabolism and could be associated with reduction or interruption in fruit respiration rate by boric acid and NAA, thus reduced the loss of water which is the measure of fruit weight [11]. These result are in conformity with the studies conducted by El-Sherif *et al.* [12] and Singh *et al.* [13].

Effect on palatability ratingof guava fruits

The highest mean palatability rating (16.33 out of 20) was noted in the fruit treated with NAA @ 400ppm (T_6) on 7 days of storage which was closely followed by 16 in control (T_0), boric acid @ 300ppm (T_3) and boric acid 100ppm (T_1) (Table 1).The effect of chemicals on palatability rating was not significant. However, significant and decreasing trend in taste, texture and appearance in all the storage days was reported. The overall acceptability of guava fruits in all treatment was reported to be very good (14.00 to 15.67) upto 14 days of storage and was good (12.00 to 13.33) at 28 days of storage.It was revealed that

fruit treated with different chemicals, boric acid and NAA at different days of storage, get the highest score in comparison to fruits treated with boric acid 100ppm and NAA 300ppm, which was considered 'excellent' and the lowest score (below 5) in last day of observation in all treatments due to fruit spoilage.The interaction between treatments and storage days was established to be non-significant.

Effect on Total Soluble Solid (ºBrix) content of guava fruits

Significant increase was reported on TSS content of guava fruits after treatment with different concentration of boric acid and NAA at different days of low temperature storage (Table 1). The interaction effect was also found to be significant. The Total Soluble Solid ranged from 8.00^0Brix in T_0 at 7 days of cold storage to 11.10^0Brix in T_6 (NAA @ 400 ppm) at 35th day of storage. The high range of Total Soluble Solid might be due to the efficient translocation of photosynthates to the fruit by regulation of boric acid and naphthalene acetic acid (NAA) as confirmed by findings ofRawat *et al*. [14]. Brothakar *et al*. [15] had proposed complete hydrolysis of starch as a reason for increase in TSS of guava fruits during storage.

Effect on titratable acidity (%) of guava fruits

The acidity percentage of guava fruits treated with different concentration of boric acid or NAA had shown greater variation between treatments at different days of storage (Table 2). The days of storage shown a significant effect on acid content of fruit in different chemical treatments.The acidity percentage content in different chemicals ranged from 2.20% to 0.63% in cold storage. At 35 days of storage the highest acidity (1.77%) was reported in NAA @ 300ppm and lowest (0.90%) was reported in boric acid (100ppm) treated fruits. In cold storage the increased acidity (%) was reported from 7th day to 28th day of storage, thereafter decrease in acidity was reported in different treatments. Acidity per cent age of guava fruit might have been augmented due to higher synthesis of nucleic acids, on account of maximum availability of plant metabolism [12].

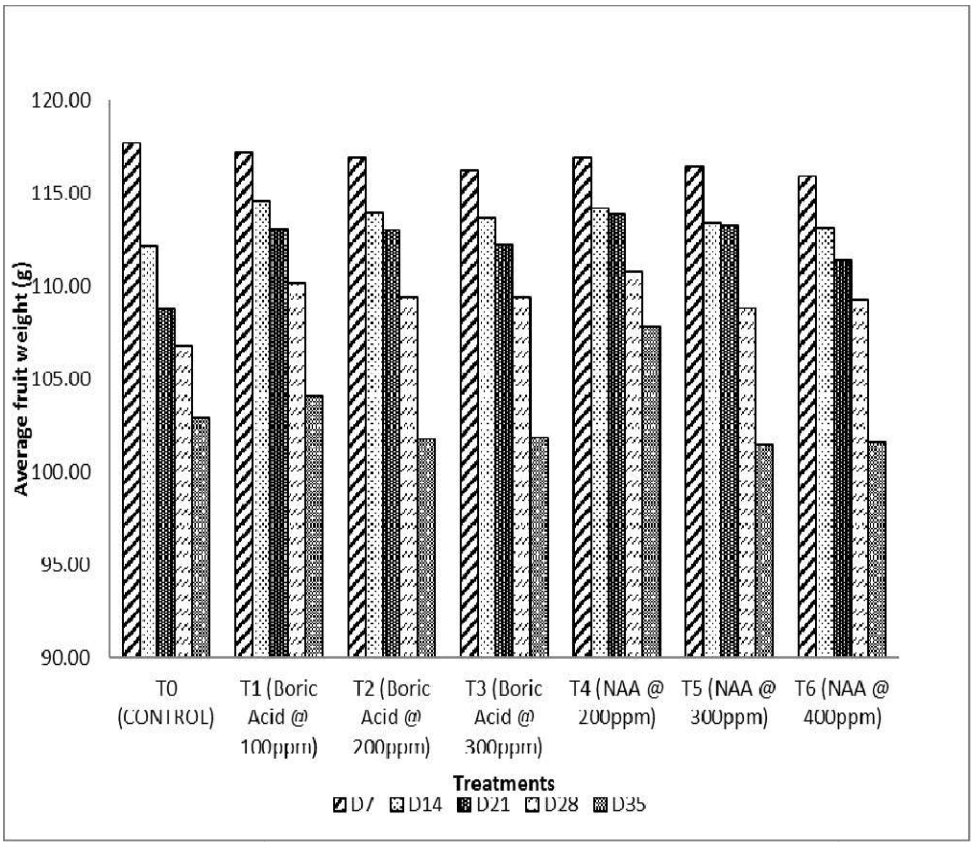

Figure 1: Average fruit weight of guava fruits after postharvest treatment with boric acid and NAA

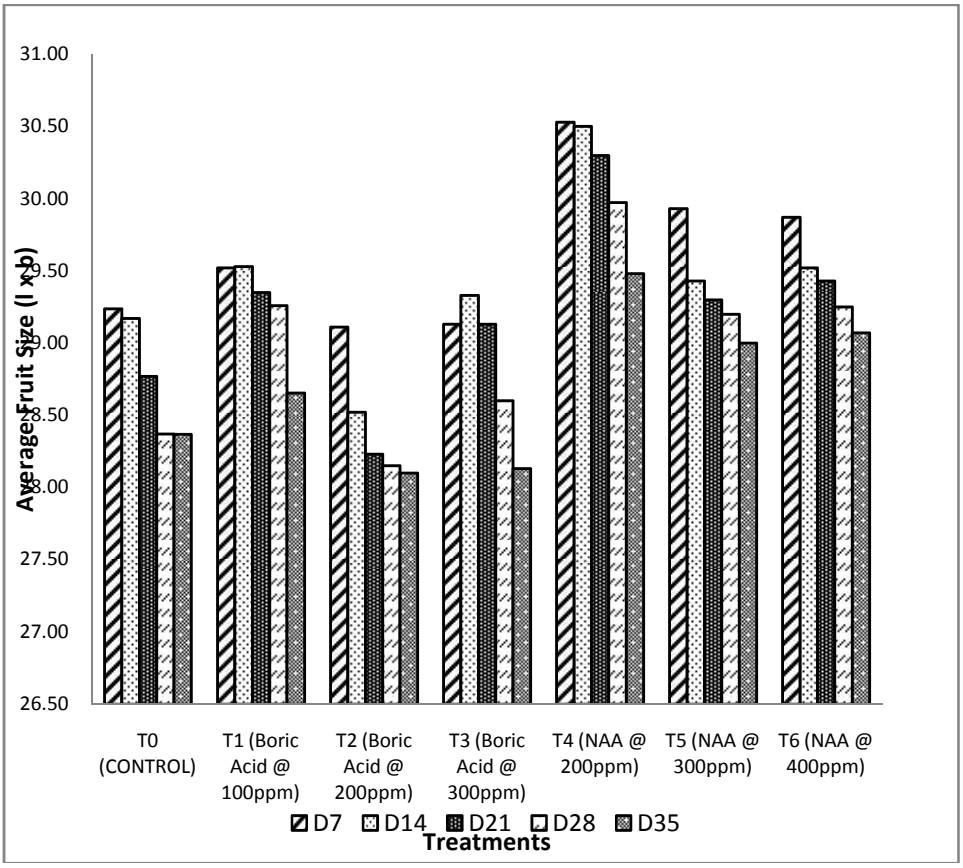

Figure 2: Average fruit size of guava fruits after postharvest treatment with boric acid and NAA

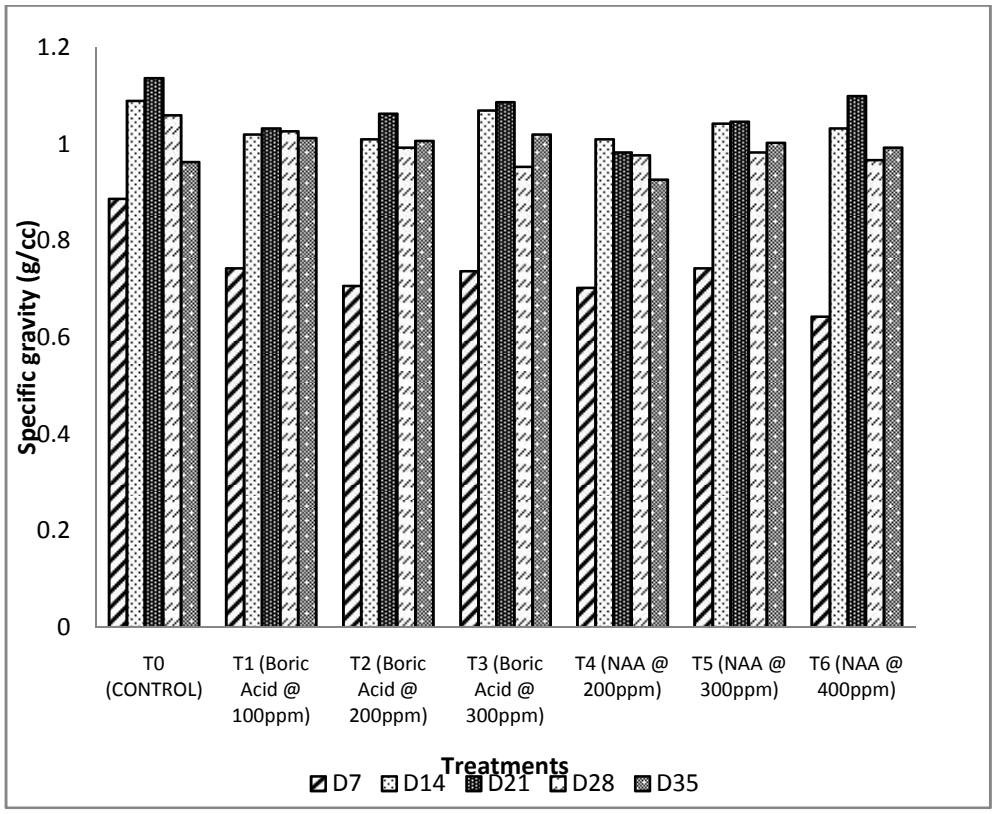

Figure 3: Specific gravity of guava fruits after postharvest treatment with boric acid and NAA

Table 1: Palatability rating and T.S.S. of guava fruits after postharvest treatment with boric acid and NAA

TREATMENT/ DAYS	Palatability Rating (Maximum Value-20)						T.S.S. (^{0}Brix)					
	Day 7	Day 14	Day 21	Day 28	Day 35	Mean	Day 7	Day 14	Day 21	Day 28	Day 35	Mean
T_0 (Control)	16.00	14.00	13.67	12.67	6.33	**12.53**	8.00	9.60	9.34	9.97	10.20	**9.42**
T_1 (Boric Acid @ 100ppm)	16.00	15.67	13.67	12.67	5.00	**12.60**	8.20	9.40	9.50	9.70	10.40	**9.44**
T_2 (Boric Acid @ 200ppm)	15.00	15.67	13.67	12.00	7.00	**12.67**	8.87	9.00	9.37	9.60	10.67	**9.50**
T_3 (Boric Acid @ 300ppm)	16.00	15.00	13.67	13.33	4.00	**12.40**	8.00	9.20	9.40	9.80	10.87	**9.45**
T_4 (NAA @ 200ppm)	15.00	14.67	13.00	12.67	10.00	**13.07**	8.20	9.60	9.80	10.20	10.53	**9.67**
T_5 (NAA @ 300ppm)	15.67	14.00	13.67	13.33	7.33	**12.80**	8.67	9.80	9.97	10.40	10.80	**9.93**
T_6 (NAA @ 400ppm)	16.33	14.33	14.00	13.33	5.33	**12.66**	8.60	9.67	9.90	10.60	11.10	**9.97**
Mean	**15.71**	**14.76**	**13.62**	**12.86**	**6.43**		**8.36**	**9.47**	**9.61**	**10.04**	**10.65**	
Factors	**C.D.**						**C.D.**					
Treatment (T)	**NS**						**0.237**					
Days of Storage (D)	**0.908**						**0.269**					
Treatment X Days (T X D)	**NS**						**0.712**					

Table 2: Titratable acidity (%) and ascorbic acid content (mg/100g) of guava fruits after postharvest treatment with boric acid and NAA

TREATMENT / DAYS	Titratable acidity (%)						Ascorbic Acid (mg/100g)					
	Day 7	Day 14	Day 21	Day 28	Day 35	Mean	Day 7	Day 14	Day 21	Day 28	Day 35	Mean
T_0 (Control)	0.63	1.07	1.43	1.47	1.07	**1.134**	231.0	203.3	177.3	153.7	129.0	**178.86**
T_1 (Boric Acid @ 100ppm)	1.07	1.03	1.70	1.70	0.90	**1.280**	234.3	206.0	178.0	157.7	135.3	**182.26**
T_2 (Boric Acid @ 200ppm)	0.87	1.00	1.70	1.73	1.23	**1.306**	234.3	205.7	178.3	158.3	136.0	**182.52**
T_3 (Boric Acid @ 300ppm)	0.90	0.90	1.70	1.17	1.13	**1.160**	235.0	206.7	177.0	157.7	135.7	**182.42**
T_4 (NAA @ 200ppm)	1.57	2.10	1.27	1.40	1.67	**1.602**	233.0	206.7	178.7	160.0	178.0	**191.28**
T_5 (NAA @ 300ppm)	1.10	1.10	1.47	0.73	1.77	**1.234**	232.7	207.3	178.0	161.0	138.3	**183.46**
T_6 (NAA @ 400ppm)	2.20	2.20	1.90	1.33	1.57	**1.840**	234.3	207.0	178.3	159.0	139.3	**183.58**
Mean	**1.19**	**1.343**	**1.595**	**1.362**	**1.333**		**233.5**	**206.1**	**178.0**	**158.2**	**141.7**	
Factors	**C.D.**						**C.D.**					
Treatment (T)	**0.164**						**4.645**					
Days of Storage (D)	**0.186**						**5.267**					
Treatment X Days (T X D)	**0.491**						**NS**					

Effect on Vitamin C (mg/100g) content of guava fruits

The vitamin C content in different chemicals range between (235.0 to 129.0mg/100g) under different treatments during cold storage of guava fruits (Table 2). The high vitamin-C content was observed in T_3(235.0 mg/100g) and the lowest in control (129.0 mg/100g). There was significant difference in chemical treatment as well as in no of days in storage. The result indicates that there is a decrease in vitamin C along the storage days in all the treatments. Boric acid @ 100, 200, and 300ppm are statistically at par as compared to control, whereas the rest of the treatments were significantly different as compared to control. There was no significant difference between treatment and days of storage. The interaction between chemical treatment and days of storage temperature of guava fruit with reference to vitamin C content was found to be non-significant. The decrease in ascorbic acid during storage of guava fruits is associated with activity of ascorbic acid oxidase which catalyses oxidation of ascorbic acid into 2-

dehydroascorbic acid as proposed by Ohkawa *et al.* [16]. Similar result was also reported by Dhaka *et al*. [17] in Kinnow fruit juice.

CONCLUSION

The best result was shown in the chemicals treated with NAA at different doses of 200ppm, 300ppm and 400ppm for fruits stored at cold storage temperature. The fruits treated with boric acid have higher rate of fruit spoilage, as compared to NAA. The fruit treated with boric acid started to spoil from the 20th day of storage and NAA treated fruits showed spoilage sign at 26th day of storage. Thus, the shelf life of the guava can be maintained with the use of NAA upto 26 days in cold storage with good consumer acceptability.

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