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Effect of Postharvest treatment of Guava fruits with 1-methylcyclopropene and Gibberellin on storage life and fruit quality

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ABSTRACT
Guava is a climacteric and perishable fruit which cannot be kept for longer duration under ambient condition. Postharvest treatment of guava fruits by using 1-MCP (1-methylcyclopropene) and gibberellin (GA_3) can be suitable to enhance shelf life of guava fruits without any deterioration in fruit quality. The present research paper emphasises the increase in TSS and acidity content of guava fruits during ambient storage when treated with 1-MCP and GA_3 prior to storage. 1-MCP treated fruits had also retained significantly high fruit size, fruit weight, palatability rating, ascorbic acid content and titratable acidity in comparison to GA_3 treated or untreated guava fruit. A positive impact of 1-MCP was observed in maintaining keeping quality of guava fruits up to 9 days of storage under ambient condition. Postharvest treatment of guava fruits with 500 -1000 ppb concentration of 1-MCP had retained significant palatability value of 11.83 to 12.17, TSS of 7.57 to 7.67%, acidity 0.42 to 0.53% and ascorbic acid of 175.00 to 176.33 mg per 100g.
Keywords: *1-Methylcyclopropene, ascorbic acid, gibberellin, postharvest, shelf life*

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INTRODUCTION

Guava (*Psidium guava* L.) is a tropical fruit and have its place in family- Myrtaceae. It is often discussed to as "Apple of the Tropics" due to its dessert and culinary usages. Guava is a rich source of vitamin C and pectin. Besides this, it is a rational source of vitamin A and minerals like calcium and phosphorus. The Total area under Guava Cultivation in India had increased quite significantly from the Mid-Nineties. Guava is fifth most important fruit in area and production after mango, banana, citrus and papaya in India. Guava accounts for 2.51 lakh ha area with an annual production of 40.83 lakh MT and productivity 16.3 MT per ha in year 2014-15 [1]. Guava has 4.1 percent of share in total fruit production in India as presented through Figure 1 [1]. In Punjab, guava flowers twice in a year, the first bloom occurs in April-May for the rainy season crop and the second in August-September for the winter season crop. Rainy season crop is heavily infested with fruit flies. However, the fruits of winter season crop matures but do not develop properly on the tree due to low temperature. Artificial methods such as temperature modification and use of some chemicals or growth regulators may enhance the ripening as well as the storage of the guava fruits. The important objective of storage of fruits is to extend their period of availability in the market. A substantial quantity of guava fruits are destroyed and rotten due to lack of proper storage facilities. The post-harvest losses are estimated to be 25-30% because of poor storage infrastructure facilities.

In, Punjab, guava bears two main crops, rainy and winter. The rainy season fruits have rough fruit surface and highly infested with fruit fly while, the winter season fruits are good in quality, free from infestation and provide high market values [2]. Guava is quite hardy, prolific bearer and highly remunerative even without much care. Guava is an ideal fruit for nutritional security. It is known as "poor man's apple" because fruits are sold at a cheaper rate during the season and hence they are within the reach of the common people. Under ambient condition fruits become over ripe and unusable within a week, whereas the cold storage of fruits at 8-10^{0}C temperature and 85-90% RH can keep the fruit usable up to 15 days [3]. But cold storage facilities are not available to the poor farmers of rural area so extension of shelf life under ambient condition is the need of common people. Various other methods of extending the shelf-life of fresh fruits have been experimented and recommended for different kinds of fruits viz. skin coating with wax, growth regulator and chemicals treatments, packaging materials, 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. Considering the importance of postharvest treatments of fruits with suitable chemicals like 1-MCP and GA_3 the investigatory research was carried out with the objective to determine the influence of 1-MCP and GA_3 for enhancing the shelf life of winter guava stored under ambient condition.

MATERIALS AND METHODS

The present investigation will be carried out at Postharvest Agriculture Lab, School of Agriculture, Lovely Professional University, Punjab, in December- January, 2014. The sub-region is characterized by hot dry sub-humid to semi-arid transition with dry summers and cool winters. The mean annual air temperature ranges from 24 to 26^{0}C. The guava fruits were harvested, sorted and selected for uniform size and quality. The fruits were dipped for 2 minutes in two chemicals with different concentration i.e. 1-MCP 500ppb, MCP 750ppb, MCP 1000ppb, GA_3 50ppm, GA_3 100ppm and GA_3 150ppm. The fruits were dried in ventilated place and were packed in 2-5 kg CFB boxes. The fruits were stored at ambient room temperature for 12 days and qualitative studies were conducted at 3, 6, 9 and 12 days of storage to identify the best chemical strength for storage of guava fruits.

The experimental design includes seven treatments with three replications. The treatments were T_0 (Control- untreated fruits), T_1 (GA_3 50ppm), T_2 (GA_3 100ppm), T_3 (GA_3 150ppm), T_4 (1-MCP 500ppb), T_5 (1-MCP 1000ppb), T_6 (1-MCP 1500 ppb). Ten fruits of uniform fruit size and weight were randomly selected and average fruit size and fruit weight was calculated. Fruit size as length and breadth was measured by using vernier callipers and was expressed in unit of cm^2. Fruit weight was measured by using the pan balance and was expressed in unit of gram (g). Palatability rating was judged by a team of five judges and were rated under five categories viz. excellent (16-20), very good (14-16), good (12-14), fair (10-12) and poor (below 10). The hand refractometer was used to determine total soluble solids (TSS) content of the fruit which was further expressed in percentage [4]. The ascorbic acid content of fruit juice was estimated by using 2, 6-dichlorophenolindophenol dye [4] and expressed in mg/100g of fruit by using following formula:

$$\text{Ascorbic acid (mg per 100g)} = \frac{\text{Titre Value x Dye factor x Final volume made up}}{\text{Aliquot of extract x weight of sample taken}} \text{ x } 100$$

Titratable acidity was measured by titrating the diluted fruit juice against N/10 NaOH solution and using phenolphthalein as an external indicator [4]. The titre value was expressed as percentage titratable acidity by using following formula:

$$\text{Titratable Acidity (\%)} = \frac{\text{Titre value x Normality of NaOH x Equivalent weight of acid}}{\text{Volume of sample taken x 1000}} \text{ x } 100$$

The statistical analysis of observations was carried out to determine overall significant differences between the treatments and days after storage at 5% level of significance [5].

RESULT AND DISCUSSIONS

Effect on fruit weight (g) of guava

The fruit weight was significantly affected by postharvest treatment of guava fruits with 1-MCP and GA_3. The maximum reduction (118.11g at 3 days to 104.76g at 12 days) in fruit weight reported in untreated fruits (Figure 2). The minimum reduction in fruit weight during storage was reported in T_4 from 117.75g at 3 days to 111.15g at 12 days which is followed by T_1 from 117.37g at 3 days to 110.11g at 12 days of storage. The retention of higher fruit weight due to application of GA_3 and 1- MCP was due to their stimulatory effect on fruit metabolism. These could be probably due to the reduced or delayed fruit respiration in GA_3 and 1-MCP treated fruits which has thus, reduced the loss of water. These are in orthodoxy with the result observed by Blankship and Dole [6], EL-Sherif *et al.* [7], and Singh *et al.* [8].

Effect on fruit size (cm^2) of guava

The highest average fruit size (30.33 cm^2) was reported in T_4 followed by T_0 (30.07cm^2) while the minimum size (28.68 cm^2) was recorded in T_3 (Figure 3). The fruit size was not significantly affected by the application of different chemicals GA_3 and 1-MCP. The effect of GA_3 and 1-MCP had not significantly influenced the fruit size change during storage of fruits. The higher size of the fruit was due to combine application of GA_3 and 1-MCP may be attributed to their stimulatory effect of plant metabolism as confirmed the findings of Singh *et al.* [8] and Rawat *et al.* [9]. Ramezani and Shekafandeh [10] had reported higher fruit size in olive due to application of 0.5% $ZnSO_4$ + GA_3 30ppm. Gaur *et al.* [11] had also reported significant effect of foliar application of GA_3 and micronutrients on yield and reproductive parameters of winter season guava.

Effect on palatability rating (0-20) of guava fruits

The highest mean palatability rating (10.23 out of 20) was noted in fruit treated with T_6 (1-MCP@1000ppb) which was closely followed by T_5 1-MCP @ 750ppb (10.00) while the palatability rate was minimum in T_0 (8.07) in untreated fruits (Table 1). The effect of chemical on palatability rating was not significant, it has been observed that their decrease in taste, texture and appearance showered downward trend at all the storage days. The fruits with palatability rating 14.91 were rated as 'very good' at 3 day of storage for all treatments, followed by 13.41 as 'good' at 6 days of storage and 10.88 as 'fair' at 9 days of storage of guava fruits under ambient temperature storage. There was a rapid decrease in score (below 10) 'poor' at last day of reading because of the internal break down. The result of rating, conducted by a panel of four judges, exposed that fruit treated with 1-MCP got highest score of (16.33) in fruit treated with 1-MCP @1000ppb and 1-MCP @ 750 ppb which were adjudged 'excellent'. The interaction between treatments and days of storage was reported to be significant. Mahajan *et al*. [12] advocated that postharvest application of 1-MCP improves acceptability of guava fruits after storage and is in conformity with the findings of Mahajan *et al*. [13] for pear fruits. The high value of palatability for 1-MCP treated fruits may be due to its influence on internal ethylene levels to delay ripening as confirmed by Zhang *et al.* [14].

Effect on TSS (Total Soluble Solids) content of guava fruits

The TSS of guava fruits as affected by different treatments (Table 1 and Figure 4) shows that the TSS was increased significantly with different treatments and at different days. The interaction effect was also found to be significant. The TSS ranged between 6.00 for T_0 at 3rd day to 8.97% for T_0 at 12th days of storage whereas the fruits treated 1-MCP and GA_3 showed relatively lower TSS content with lowest mean TSS for T_4 (7.18) followed by T_5 (7.19) and T_6 (7.21). TSS was found to be increased with increase in no of days in all treatments with greater increase in 1-MCP treated fruits like T_4 (from 6.0 to 8.50%) followed by T_5 (from 6.07 to 8.47%) and T_6 (from 6.03 to 8.43%). The increase in TSS during storage may be due to breakdown of complex organic metabolites into simple molecules or hydrolysis of starch into sugar [12,13]. Similar reports was also given by Rahman *et al*. [15] in banana fruits. Highest value of TSS was also reported by Deaquiz *et al.* [16] in yellow pitahaya fruits due to treatment of fruits with 1-MCP.

Effect on acidity (%) content of guava fruits

The days of storage show a significant effect on acid content of fruits (Table 2). All the treatments showed a regular increase in acid content with increase in storage duration. In control the gradually increase in acidity was shown but a very little increase was held in treatments. The acidity content in different chemicals ranges from 1.03 to 0.13 % during storage. The highest range was observed in T_0 (untreated guava fruits) in which acidity increased from 0.30% at 3rd day 1.03% at 12th day of storage. The minimum average acidity was reported with fruits treated with 1-MCP followed by the fruit treated with GA_3 while the untreated fruits showed maximum acidity during storage. The interaction between treatment and days of storage were found to be significant. Acidity percentage of guava might have been increased due to higher synthesis of nucleic acid, on account of maximum availability of fruit metabolism. El-Sherif *et al.* [7] has reported similar findings and can be confirmed by findings of Bashir *et al.* [17] and Basseto *et al.* [18] in guava fruits while Woolf *et al.* [19] in 'Hass' avocado.

Effect on ascorbic Acid (mg/100gm) content of guava fruits

The mean Vitamin C (ascorbic acid) contents in different chemical ranged from 192.92 to 195.92 mg/100g with the highest value of ascorbic acid in fruits treated with 1-MCP @ 500ppb (195.92 mg/100g) followed by 1-MCP @1000 ppb (195.58 mg/100g) and 1-MCP @750ppb (195.50 mg/100g) while the lowest value was reported with untreated fruits (192.92 mg/100g) (Table 2). All the treatments showed a significant decrease in Ascorbic acid content and only 50% of Ascorbic acid was retained after 12 days of storage. The maximum drop in ascorbic acid content was reported in untreated fruits while 1-MCP treated fruits showed maximum retention. There was no significant difference between treatments and days of storage temperature. 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. Increase of ascorbic acid percentage of guava fruit might be due to high synthesis of nucleic acid on account of maximum availability of fruit metabolism El- Sherif *et al.* [7]. Reddy *et al.* [20] had advocated the significantly high total antioxidant capacity in 1-MCP treated guava which might be responsible for reducing oxidation of ascorbic acid to keep Vitamin-C content of fruits significant during storage. Similar activity of 1-MCP has also been reported by Wang *et al.* [21] in tomato fruits.

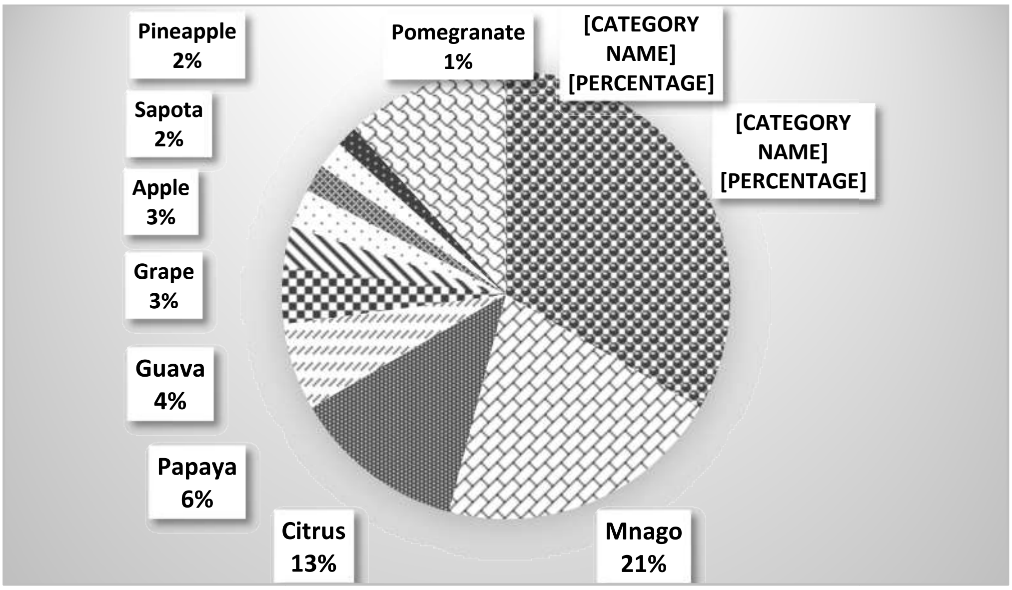

Figure 1: Production share of major fruits in India during 2014-15 [1]

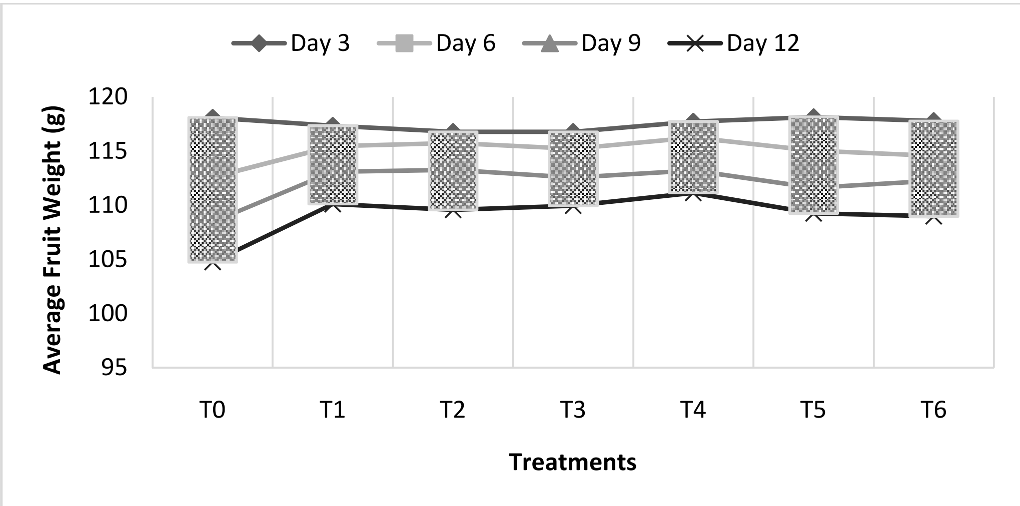

Figure 2: Average fruit weight (g) of guava fruits treated with GA_3 and 1-MCP and stored under ambient condition

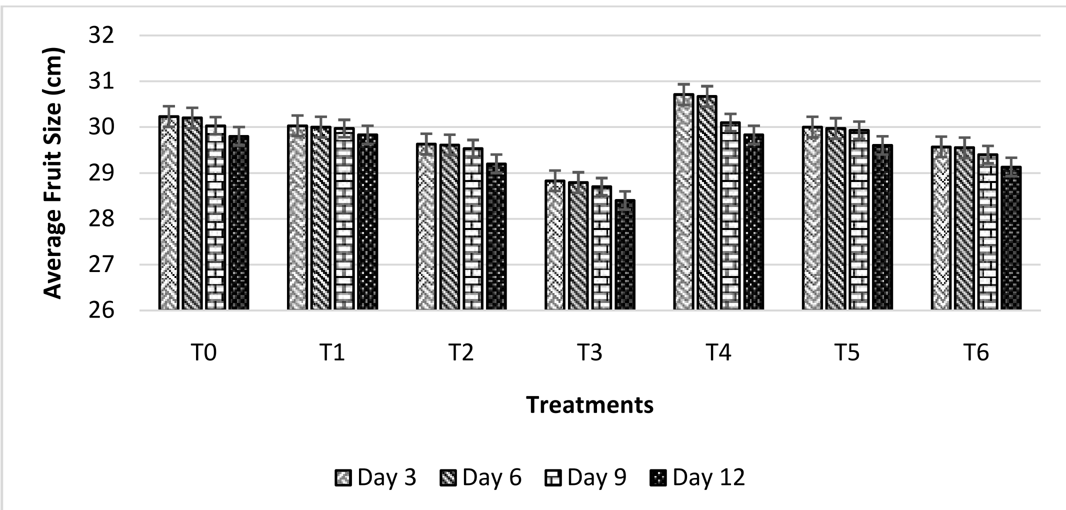

Figure 3: Average Fruit Size of guava fruits treated with GA_3 and 1-MCP and stored under ambient condition

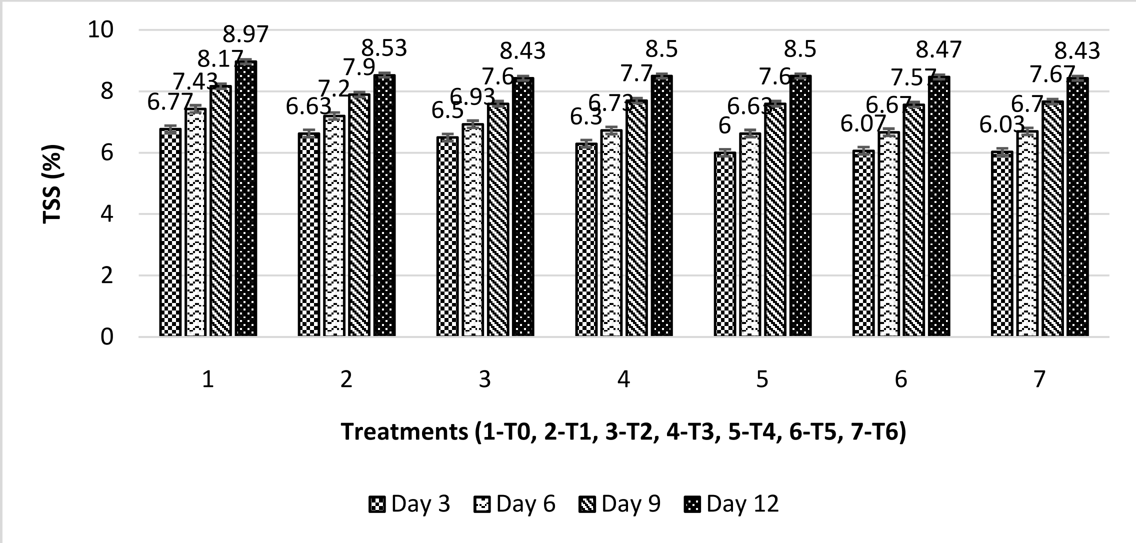

Figure 4: TSS (%) content of guava fruits treated with GA_3 and 1-MCP and stored under ambient condition

Table 1: Palatability rating (0-20) and TSS (%) content of GA_3 and 1-MCP treated guava fruits stored under ambient condition

Treatments /Days	Palatability rating (0-20)					TSS (%)				
	Day 3	Day 6	Day 9	Day 12	Mean	Day 3	Day 6	Day 9	Day 12	Mean
Control- untreated fruits	13.50	12.17	9.33	5.33	**8.07**	6.77	7.43	8.17	8.97	**7.84**
GA_3 50ppm	14.17	13.00	10.67	7.33	**9.03**	6.63	7.20	7.90	8.53	**7.56**
GA_3 100ppm	14.50	13.00	10.50	6.33	**8.87**	6.50	6.93	7.60	8.43	**7.36**
GA_3 150ppm	14.00	12.50	10.17	6.33	**8.60**	6.30	6.73	7.70	8.50	**7.31**
1-MCP 500ppb	15.83	14.17	11.83	7.67	**9.90**	6.00	6.63	7.60	8.50	**7.18**
1-MCP 1000ppb	16.00	14.50	11.50	8.00	**10.00**	6.07	6.67	7.57	8.47	**7.19**
1-MCP 1500ppb	16.33	14.50	12.17	8.17	**10.23**	6.03	6.70	7.67	8.43	**7.21**
Mean	**14.91**	**13.41**	**10.88**	**7.02**		**6.33**	**6.90**	**7.74**	**8.55**	
Factors	**CD**	**SE(d)**	**SE(m)**			**CD**	**SE(d)**	**SE(m)**		
Factor (Treatments)	0.53	0.27	0.19			0.161	0.081	0.058		
Factor (Days)	0.60	0.30	0.21			0.183	0.092	0.065		
Factor (Treatments x Days)	N/S	0.80	0.56			N/S	0.244	0.173		

Table-2: Acidity (%) and ascorbic acid (mg/100g) content of GA_3 and 1-MCP treated guava fruits stored under ambient condition

Treatments /Days	Acidity (%)					Ascorbic Acid (mg/100g)				
	Day 3	Day 6	Day 9	Day 12	Mean	Day 3	Day 6	Day 9	Day 12	Mean
Control- untreated fruits	0.30	0.53	0.60	1.03	**0.61**	254.67	219.67	172.00	125.33	**192.92**
GA_3 50ppm	0.30	0.53	0.63	0.90	**0.59**	255.00	221.00	174.33	127.33	**194.42**
GA_3 100ppm	0.13	0.33	0.53	0.80	**0.45**	255.00	223.00	176.00	126.33	**195.08**
GA_3 150ppm	0.23	0.37	0.43	0.67	**0.42**	254.33	222.00	177.00	127.33	**195.17**
1-MCP 500ppb	0.17	0.37	0.43	0.63	**0.40**	255.67	223.67	176.33	128.00	**195.92**
1-MCP 1000ppb	0.17	0.37	0.43	0.53	**0.37**	256.00	224.00	175.00	127.00	**195.50**
1-MCP 1500ppb	0.20	0.43	0.53	0.73	**0.47**	255.00	223.67	176.33	127.33	**195.58**
Mean	**0.21**	**0.42**	**0.51**	**0.76**		**255.10**	**222.43**	**175.29**	**126.95**	
Factors	**C.D.**	**SE(d)**	**SE(m)**			**C.D.**	**SE(d)**	**SE(m)**		
Factor (Treatments)	0.06	0.03	0.02			4.645	2.344	1.658		
Factor (Days)	0.06	0.03	0.02			5.267	2.658	1.88		
Factor (Treatments x Days)	0.17	0.09	0.06			N/S	7.033	4.973		

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