Plant Archives Vol. 19 No. 2, 2019 pp. 3005-3010 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

POST-HARVEST TREATMENT FOR IMPROVEMENT OF SHELF LIFE IN GUAVA (*PISIDIUM GUAJAVA*.L) CULTIVAR 'ALLAHABAD SAFEDA' UNDER AMBIENT STORAGE CONDITION

Manpreet Kaur, Gurpreet Singh* and Manish Bakshi

Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, India.

Abstract

Chemically treated guava fruits were stored under ambient conditions during 2017-18 and 2018-19. Guava fruits were treated with $CaCl_2$ (1% and 2%), $CaNO_2$ (1% and 2%), naphthalene acetic acid (100 ppm and 200 ppm) and salicylic acid (100 ppm and 200ppm). $CaNO_2$ (2%) was effective to maintain highest palatability rating, specific gravity, maximum firmness and ascorbic acid in both the years of study. Minimum decay was noted in salicylic acid (200 ppm) treated fruits. $CaNO_2$ (2%) treated fruits showed minimum physiological loss in weight. Quality parameters were also affected by the treatment and storage conditions. Naphthalene acetic acid (200 ppm) was desirable to maintain higher total soluble solids and total sugar. Minimum acidity was noted in Naphthalene acetic acid (100 ppm) in both the years. There was non-significant effect noted in fruits for fruit size (length and breadth) but $CaNO_2$ (2%) retained maximum fruit size under ambient storage conditions. Shelf life of stored fruits was less than 15 days.

Key words: Chemical coating, fruit spoilage, postharvest management

Introduction

Guava (*Psidium guajava* L.) belongs to family Myrtaceae and is the fourth most important fruit crop of India. Shelf life of the guava fruit is very less. Fruits harvested in summer or rainy season have very less shelf life due to high temperature and humidity. There are several methods to improve the shelf life of guava. One of them is post harvest treatments. Post-harvest treatments have potential to preserve the quality during storage of guava fruits. Main objective of chemical treatment is to reduce the loss of fruit quality and extension shelf life of guava. Different methods are preferred to extend shelf life and biochemical properties of guava fruits. Storage of guava fruits is difficult because of its soft skin and short shelf life. It can be retained only for 4 days under ambient conditions. It is also susceptible to various post-harvest diseases during storage (Singh and Chauhan, 1987). Fruits are stored at low temperature to extend shelf life (Reyes, 1995). Various chemicals and plants growth regulators (natural and manmade) are used as pre or post-harvest treatment to retain quality attributes of guava fruits. To reduce the post-harvest losses, edible coating is also preferred than chemical treatment. These coatings slow down the rate of respiration and act as partial barrier, retain the quality of the fruit, preserve texture and colour of fruit and also enhance the market acceptability (Mahajan *et al.,* 2014). Phytochemicals *viz*., plant growth regulators at different concentration have been reported to enhance shelf life and market value of guava fruit (Sharma *et al.*, 2002). Calcium is thought to be the most important mineral element in determining fruit quality. Consequently, application of calcium in orchard management is considered as best strategy to prevent losses (Conway *et al.*, 2002). Salicylic acid is widely used safe chemical Key Laboratory of Photosynthesis and Environmental Molecular Physiology, Institute of Botany, the Chinese Academy of Sciences, Beijing 100093, China Graduate School of Chinese Academy of Sciences, Beijing 100039, China Key Laboratory of Photosynthesis and Environmental Molecular Physiology, Institute of Botany, the Chinese Academy of Sciences, Beijing 100093, China either as pre-harvest or post-harvest. It is mainly used for highly perishable crops to maintain its quality and quantity losses.

Author for correspondence

Post-harvest use of salicylic acid is responsible to effect physicochemical properties including that of biologically active compounds of fruits and vegetable (Supapvanich and Promyou, 2013). Post-harvest application of salicylic acid is also desirable to retain quality and extend shelf life of guava fruits (Singh *et al.*, 2017). Naphthalene acetic acid is a natural plant growth regulator and is used to enhance growth and development of fruit plants. Post-harvest application of NAA is desirable to maintain shelf life of guava fruits under ambient condition (Singh *et al.,* 2017).

Materials and Methods

Present investigation was carried out in Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara during the year 2017-18 and 2018-19. Guava fruits were harvested during 3rd week of December from new orchard of Punjab Agriculture University, Ludhiana. Medium sized guava fruits were harvested at mature green stage and collected in plastic crates. The harvested fruits were cleaned, sorted and subjected to pre-cooling treatment. The fruits were exposed to dip treatment with calcium chloride, calcium nitrate, salicylic acid and naphthalene acetic acid for 3 minutes. This experiment was arranged as completely randomized design with three replications per treatment. Post-harvest treated fruits with chemical and plant growth regulator were packed in CFB (corrugated fibre box) and kept at ambient conditions (20 ± 1^{0}C) for analyzing physico-chemical parameters. Observations were recorded at 3, 6 and 9 days interval after storage. There were nine treatments *viz.* T_1 (Calcium Chloride 1%), T_2 (Calcium Chloride 2%), T_3 (Clacium nitrate 1%), T_4 (Clacium nitrate 2%), T_5 (Naphthalene acetic acid 100ppm), T_6 (Naphthalene acetic acid 200ppm), T_7 (Salysilic acid 100ppm), T_8 (Salysilic acid 200ppm) and T_9 (Control). Fruit physical measurements were recorded using vernier calliper and electronic weighing scale. TSS was determined using Hand Refractometer. Total sugars were estimated as per method given by Ranganna (1986). Ascorbic acid content was estimated using standard procedure as described by A.O.A.C. (1984). Statistical analysis was performed using OPSTAT software.

Results and Discussion

Physical parameters

Significant variation was observed in physiological loss in fruit weight of guava cv. Allahabad Safeda treated with different chemicals Table 1. Loss of weight increased with progression of storage period. During storage period, lowest physiological loss of weight was recorded in calcium nitrate (2%) at 9th day of storage with a mean value (5.75%) followed by mean value of (6.01%) recorded under calcium nitrate (1%) treatment. Highest physiological loss of weight was recorded under control (9.71%). PLW significantly increased with the increase in storage period in all the treatments due to increase in respiration and transpiration processes during storage (Jawandha *et al.*, 2012). However, calcium nitrate treated fruits responded better due to the effect of calcium on cell wall. Similar results with decreased physiological loss of weight in papaya variety "Red lady" were reported by

Table 1: Effect of post-harvest treatments on physiological loss in weight (%) of guava cv. Allahabad Safeda during ambient storage conditions.

		Physiological loss in weight (%)								Pooled
		2017-18				2018-19				mean
		Storage intervals (Days)								
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	0.80	3.19	14.97	6.32	0.82	3.25	14.89	6.32	6.32
T_2	Calcium chloride (2%)	0.73	3.15	14.52	6.13	0.81	3.21	14.46	6.16	6.15
T_3	Calcium nitrate (1%)	0.71	3.11	14.18	6.00	0.79	3.10	14.15	6.01	6.01
T_4	Calcium nitrate (2%)	0.64	3.04	13.49	5.72	0.68	3.02	13.56	5.75	5.74
T_5	Naphthalene acetic acid (100 ppm)	0.99	4.87	16.11	7.32	1.00	4.80	16.09	7.30	7.31
T_6	Naphthalene acetic acid (200 ppm)	0.94	4.59	16.00	7.18	0.98	4.44	16.02	7.15	7.17
T_7	Salicylic acid (100 ppm)	0.86	4.31	15.70	6.96	0.90	4.39	15.84	7.04	7.00
T_8	Salicylic acid (200 ppm)	0.84	4.00	15.54	6.79	0.87	4.05	15.46	6.79	6.79
T_9	Control 2.19	8.16	17.71	9.35	2.13	9.03	17.96	9.71	9.53	
	Mean	0.97	4.27	15.36	6.86	1.00	4.37	15.38	6.91	6.89
		0 day = 0				0 day = 0				
		Factors C.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.056		Treatment (t)		0.057		

Ramesh *et al.,* (2014) and in mango by Periyathambi *et al.,* (2013).

Table 2 presents the pooled mean data wherein highest firmness was maintained by calcium nitrate (2%) with highest mean value (16.42 kg/cm^2). Minimum mean value of firmness was reported in control (14.14 kg/cm^2). With the passage of time reduction in fruit firmness was probably due to hydrolytic enzyme activity (Jawandha *et al.,* 2012). Fruit firmness is effectively maintained by calcium treatments due to its direct impact on cell wall strengthening (Kaur *et al*., 2017). The results are in conformity to those reported by Deepthi *et al.,* (2016) wherein calcium nitrate (2%) treatment in Sardar variety of guava was responsible for maintaining maximum firmness. Specific gravity of the treated guava fruits also varied as the storage period extended (Table 3). Highest mean of specific gravity (0.92 g/ml) observed in Calcium nitrate (2%). Specific gravity gradually decreases during the storage due to loss of weight and volume (Singh *et al.,* 2017). A decrease in specific gravity of ber fruits during storage (Pareek *et al*., 2009). Similar result was found by Ramkrishan and Godara (1993).

Table 2: *Effect of post-harvest treatments on firmness (kg/cm^2) of guava cv. Allahabad Safeda during ambient storage conditions.*

Firmness (kg/cm^2)										
		2017-18				2018-19				Pooled
		Storage intervals (Days)								mean
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	17.33	16.20	13.48	15.67	17.45	16.04	13.47	15.65	15.66
T_2	Calcium chloride (2%)	17.48	16.44	13.87	15.93	17.46	16.42	13.94	15.94	15.94
T_3	Calcium nitrate (1%)	17.52	16.80	14.00	16.11	17.47	16.81	14.12	16.13	16.12
T_4	Calcium nitrate (2%)	17.24	16.43	15.51	16.39	17.28	16.46	15.52	16.42	16.41
T_5	Naphthalene acetic acid (100 ppm)	16.35	15.13	13.82	15.10	16.40	15.21	13.91	15.17	15.14
T_6	Naphthalene acetic acid (200 ppm)	16.31	15.20	13.84	15.12	16.41	15.24	13.95	15.20	15.16
T_7	Salicylic acid (100 ppm)	16.48	15.37	14.12	15.32	16.45	15.43	14.19	15.36	15.34
T_8	Salicylic acid (200 ppm)	16.78	16.09	13.16	15.34	16.91	16.09	13.10	15.37	15.36
T_9	Control	15.98	14.40	12.00	14.13	15.90	14.38	12.15	14.14	14.14
	Mean	16.83	15.78	13.76	15.46	16.86	15.79	13.82	15.49	15.48
		0 day = 17.70				0 day = 17.77				
		FactorsC.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.050		Treatment (t)		0.049		

Table 3: Effect of post-harvest treatments on specific gravity (g/ml) of guava cv. Allahabad Safeda during ambient storage conditions.

Specific gravity (g/ml)										
		2017-18				2018-19				Pooled
		Storage intervals (Days)								mean
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	0.92	0.84	0.80	0.85	0.91	0.87	0.75	0.84	0.85
T_2	Calcium chloride (2%)	0.91	0.88	0.80	0.86	0.94	0.90	0.80	0.88	0.87
T_3	Calcium nitrate (1%)	0.94	0.89	0.81	0.88	0.93	0.91	0.87	0.90	0.89
T_4	Calcium nitrate (2%)	0.95	0.91	0.85	0.90	0.96	0.93	0.86	0.92	0.91
T_5	Naphthalene acetic acid (100 ppm)	0.83	0.81	0.76	0.80	0.85	0.82	0.65	0.77	0.79
T_6	Naphthalene acetic acid (200 ppm)	0.85	0.83	0.81	0.83	0.84	0.82	0.72	0.79	0.81
T_7	Salicylic acid (100 ppm)	0.86	0.84	0.81	0.84	0.85	0.83	0.74	0.81	0.83
T_8	Salicylic acid (200 ppm)	0.87	0.84	0.85	0.85	0.88	0.82	0.80	0.83	0.84
T_9	Control	0.77	0.72	0.68	0.72	0.73	0.70	0.65	0.69	0.71
	Mean	0.88	0.84	0.80	0.84	0.88	0.84	0.76	0.83	0.84
		0 day = 1.08				0 day = 1.04				
		Factors C.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.031		Treatment (t)		0.032		

Presented data in table 4 showed the spoilage (%) of guava fruits for different treatment and storage intervals. Spoilage increased with advancement of the storage period. However, minimum spoilage (7.25%) was recorded in fruits treated with salicylic acid (200 ppm) whereas maximum mean spoilage (18.10 %) was recorded in control. Salicylic acid has a positive effect for post-harvest disease resistance, decay, oxidative stress, ethylene biosynthesis and action, fruit ripening, respiration and also discussed about their nutritional quality (Asghari and Aghdam, 2010). Pre and post-harvest application of Salicylic acid was found effective to control decay in strawberry by Babalar *et al.,* (2007). Similar results were reported by Kaur (2016).

Biochemical parameters

Total soluble solids slowly increased during the storage period Table 5. Naphthalene acetic acid (200) ppm was responsible for highest mean total soluble solids (11.22^0 brix) followed by NAA (100ppm) with a mean total soluble solids value of 11.03^0brix. Minimum total soluble solids mean (9.96^0brix) was noted in control.

Table 4: *Effect of post-harvest treatments on spoilage (%) of guava cv. Allahabad Safeda during ambient storage conditions.*

Spoilage (%)										
		2017-18				2018-19				Pooled
		Storage intervals (Days)								mean
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	0.00	9.72	19.98	9.90	0.00	15.92	30.10	15.34	12.62
T_2	Calcium chloride (2%)	0.00	6.90	22.58	9.83	0.00	11.00	21.02	10.67	10.25
T_3	Calcium nitrate (1%)	0.00	8.12	18.61	8.91	0.00	8.88	20.58	9.82	9.37
T_4	Calcium nitrate (2%)	0.00	6.74	18.14	8.29	0.00	7.81	19.07	8.96	8.63
T_5	Naphthalene acetic acid (100 ppm)	0.00	14.77	28.51	14.43	0.00	18.46	22.98	13.81	14.12
T_6	Naphthalene acetic acid (200 ppm)	0.00	10.12	20.88	10.33	0.00	7.94	24.18	10.71	10.52
T_7	Salicylic acid (100 ppm)	0.00	14.28	26.44	13.57	0.00	15.89	27.40	14.43	14.00
T_8	Salicylic acid (200 ppm)	0.00	6.70	14.32	7.01	0.00	6.83	15.62	7.48	7.25
T_9	Control	0.00	20.11	26.00	15.37	0.00	22.19	32.11	18.10	16.74
	Mean	0.00	10.83	21.72	10.85	0.00	12.38	22.87	11.75	11.30
		0 day = 0				0 day = 0				
		Factors C.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.105		Treatment (t)		0.316		

Table 5: Effect of post-harvest treatments on total soluble solids (^{0}Brix) of guava cv. Allahabad Safeda during ambient storage conditions.

Total soluble solids (^{0}Brix)										
		2017-18				2018-19				Pooled
		Storage intervals (Days)								mean
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	9.31	10.64	10.52	10.16	9.70	10.81	10.22	10.24	10.20
T_2	Calcium chloride (2%)	9.36	10.97	10.66	10.33	9.31	11.00	10.60	10.30	10.32
T_3	Calcium nitrate (1%)	9.16	10.55	10.43	10.05	9.06	10.55	10.48	10.03	10.04
T_4	Calcium nitrate (2%)	9.24	10.74	10.47	10.15	9.12	10.77	10.69	10.19	10.17
T_5	Naphthalene acetic acid (100 ppm)	11.26	12.00	9.81	11.02	11.30	12.02	9.78	11.03	11.03
T_6	Naphthalene acetic acid (200 ppm)	11.56	12.10	9.88	11.18	11.72	12.06	9.98	11.25	11.22
T_7	Salicylic acid (100 ppm)	10.80	11.15	9.92	10.62	10.76	11.09	9.96	10.60	10.61
T_8	Salicylic acid (200 ppm)	10.96	11.26	10.11	10.78	10.94	11.21	10.14	10.76	10.77
T_9	Control	10.40	11.14	8.37	9.97	10.34	11.10	8.38	9.94	9.96
	Mean	10.23	11.17	10.02	10.47	10.25	11.18	10.03	10.48	10.48
		0 day = 8.96				0 day = 8.66				
		Factors C.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.044		Treatment (t)		0.054		

Highest total soluble solids content was observed in naphthalene acetic acid treated fruits in guava by Singh *et al*., (2017). Similar results were found by Selvan and Bal (2005) and Singh (2019).

Ascorbic acid depicted declining trend with the progress of storage period (Table 6). An inquisition of the pooled data reveals that maximum ascorbic acid (208.75 mg/100ml) was obtained in fruits treated with calcium nitrate (2%) followed by treatment of calcium nitrate (1%) which recorded an ascorbic acid content of 205.35 mg/100ml). Minimum ascorbic content mean (136.69mg/100ml) was recorded under control. Calcium coating reduced the post harvest disintegration of indigenous ascorbic acid in guava fruits during storage as reported by Deepthi *et al.,* (2016). Post-harvest use of calcium salt effectively sustains ascorbic acid in papaya (Ramesh *et al*., 2014). Similar results were exhibited by Rajkumar *et al*., (2005) in papaya.

Table 7 presents the pooled mean data for total sugars. Maximum total sugars mean (7.96%) were recorded in fruits treated with naphthalene acetic acid (200ppm) followed by maximum mean (7.93%) in fruits

Table 6: Effect of post-harvest treatments on Ascorbic acid (mg/100ml) of guava cv. Allahabad Safeda during ambient storage.

Ascorbic acid (mg/100ml)										
		2017-18				2018-19				Pooled
		Storage intervals (Days)								mean
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	208.18	197.10	180.16	195.15	207.36	197.17	180.00	194.84	195.00
T_2	Calcium chloride (2%)	210.81	198.04	181.16	196.67	209.41	198.00	180.97	196.13	196.40
T_3	Calcium nitrate (1%)	213.64	203.66	198.17	205.91	213.69	203.51	197.18	204.79	205.35
T_4	Calcium nitrate (2%)	217.48	208.77	199.91	208.72	219.16	207.67	199.50	208.78	208.75
T_5	Naphthalene acetic acid (100 ppm)	181.78	160.86	134.67	159.10	182.21	159.73	134.11	158.68	158.89
T_6	Naphthalene acetic acid (200 ppm)	184.90	164.56	138.97	162.81	185.67	164.70	137.27	162.55	162.68
T_7	Salicylic acid (100 ppm)	202.17	187.74	158.87	182.93	199.17	190.12	160.16	183.15	183.04
T_8	Salicylic acid (200 ppm)	205.28	189.80	161.42	185.50	206.91	188.91	159.96	185.26	185.38
T_9	Control	158.78	141.50	114.11	138.13	153.19	140.36	112.21	135.25	136.69
	Mean	198.11	181.05	163.05	181.66	197.42	183.35	162.37	181.05	181.36
		0 day = 220.13				0 day = 221.05				
		Factors C.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.591		Treatment (t)		0.149		

Table 7: Effect of post-harvest treatments on total sugars (%)of guava cv. Allahabad Safeda during ambient storage.

Total sugars (%)										
		2017-18				2018-19				Pooled
		Storage intervals (Days)								mean
Treatments		3rd	6th	9th	Mean	3rd	6th	9th	Mean	
T_1	Calcium chloride (1%)	7.01	7.85	7.77	7.54	6.97	7.87	7.66	7.32	7.43
T_2	Calcium chloride (2%)	7.16	8	7.78	7.65	7.15	7.92	7.77	7.61	7.63
T_3	Calcium nitrate (1%)	6.02	7.82	7.8	7.21	6.01	7.76	7.81	7.19	7.20
T_4	Calcium nitrate (2%)	6.17	7.84	7.86	7.29	6.12	7.8	7.86	7.26	7.28
T_5	Naphthalene acetic acid (100 ppm)	8.02	8.17	7.62	7.94	7.97	8.16	7.61	7.91	7.93
T_6	Naphthalene acetic acid (200 ppm)	8.19	8.41	7.25	7.95	8.21	8.44	7.26	7.97	7.96
T_7	Salicylic acid (100 ppm)	7.83	8.02	7.59	7.81	7.87	7.97	7.57	7.80	7.81
T_8	Salicylic acid (200 ppm)	8.16	8.51	7.07	7.91	8.18	8.38	7	7.85	7.88
T_9	Control	7.04	7.22	5.65	6.64	7.07	7.12	5.1	6.43	6.54
	Mean	7.29	7.98	7.38	7.55	7.28	7.94	7.29	7.48	7.52
		0 day = 5.81				0 day = 5.76				
		Factors C.D. (p≥0.05)				Factors C.D. (p≥0.05)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.048		Treatment (t)		0.044		

treated with naphthalene acetic acid (100ppm). Minimum total sugar content (6.54%) was recorded under control. Similar results have have been reported by Yadav *et al.,* (2001) and Dhoot *et al.,* (1984). Naphthalene acetic acid treated guava fruits exhibited highest total sugars reported by Singh *et al.,* (2017).

Conclusion

On the basis of the present investigation, it can be concluded that under ambient storage conditions $CaNO_3$ (2%) showed minimum physiological loss in weight. Quality parameter was also affected by the treatment and storage conditions. Naphthalene acetic acid (200ppm) was desirable to maintain higher total soluble solids and total sugar. Minimum acidity was noted in Naphthalene acetic acid (100ppm) in both years. Shelf life of stored fruits under ambient storage conditions was less than 15 days.

References

Asgharia M. and M.S. Aghdam (2010). Impact of Salicylic acid on post-harvest physiology of horticultural crops *Trends Food Sci. Tech.,* **21:** 502-09.

Babalar, M., M. Asghari, A. Talaei and A. Khosroshahi (2007). Effect of pre-and post-harvest salicylic acid treatment on ethylene production, fungal decay and overall quality of Selva strawberry fruit. *Food chemistry*, **105(2):** 449-453.

Conway, W.S., C.E. Sams and K.D. Hickey (2002). Pre-and Postharvest Calcium Treatment of Apple Fruit and its Effect on Quality. *Acta horticulturae*, **(594):** 413.

Deepthi, V.P., R.C. Sekhar, D. Srihari and A.S. Sankar (2016). Guava fruit quality and storability as influenced by harvest maturity and postharvest application of calcium salts. *Plant Archives*, **16(1):** 174-182.

Dhoot, L.R., U.T. Desai and D.A. Rana (1984). Studies on the shelf-life of guava fruits with polythene packaging and chemical treatment. *J. Maharashtra Agri. Uni.,* **9(2):** 185-8.

Dohre, R. (2016). Influence of post-harvest treatments on shelf life and quality of Guava (*Psidium guajava* L.) cv. Allahabad Safeda. *krishikosh.egranth.ac.in*

Gangwar, S., H.S. Shukla, Dheerendra Katiyar and Vivek Pandey. Effect of calcium nitrate on physico-chemical changes and shelf-life of aonla (*Emblica officinalis* Gaertn) fruits. *Hort. Flora Research Spectrum*, **1(3):** 253-258 (2012).

Jawandha, S.K., N. Gupta and J.S. Randhawa (2012). Effect of post-harvest treatments on enzyme activity and quality of cold stored ber fruit. *Notulae Scientia Biologicae*, **4(4):** 86-89.

Kaur Parambir (2016). Shelf life enhancement studies in Guava (*Psidium guajava* L.) cv. Shweta. M.Sc. Thesis submitted, PAU, Ludhiana.

Mahajan, P.V., O.J. Caleb, Z. Singh, C.B. Watkins and M. Geyer (2014). Postharvest treatments of fresh produce. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, **372(2017):** 20130309.

Pareek, S., L. Kitinoja, R.A. Kaushik and R. Paliwal (2009). Postharvest physiology and storage of ber. *Stewart Postharvest Review*, **5(5):** 1-10.

Periyathambi, R., S. Navprem, K. Harminder and S.K. Jawandha (2013). Effect of post-harvest treatments on the ambient storage of mango cv. Dashehari. *Progressive Horticulture*, **45(1):** 104-109.

Rajkumar, M., P. Karuppaiah and R. Kandasamy (2005). Effect of calcium and gibberellic acid on post-harvest behaviour of papaya cv. Co2. *Indian Journal of Horticulture*, **62(4):** 327-331.

Ramesh, D., B.P. Kumar, M. Rajasekhar and D.S. Suneetha (2014). Effect of chemicals and growth regulators on post-harvest shelf-life and quality in papaya (*Carica papaya* L.) cv. Red Lady. *Journal of Horticultural Science*, **9(1):** 66-73.

Ramkrishan, N.R. and R.K. Godara (1993). Physical and chemical parameters as affected by various storage conditions during storage of Gola ber (Ziziphus mauritiana Lamk.) fruits. *Prog. Hortic.*, **25:** 60–65.

Reyes, M.U. and R.E. Paull (1995). Effect of storage temperature and ethylene treatment on guava (*Psidium guajava* L.) fruit ripening. *Postharvest Biologyand Technology*, **6(3-4):** 357-365.

Selvan, M.T. and J.S. Bal (2005). Effect of post-harvest chemical treatments on shelf life of guava during ambient storage. *Haryana Journal of Horticultural Sciences*, **34(1/2):** 33.

Sharma, R.K., J. Kumar, R.S. Shinghrot and R.K. Goyal (2002). Effect of antisenescent regulators on shelf life of winter guava. *Haryana J. Hort. Sci.*, **31(1&2):** 40-41.

Singh, J., N. Prasad and S.K. Singh (2017). Post-harvest Treatment of Guava (*Psidium guajava* L.) Fruits with Boric Acid and NAA for Quality Regulation during Ambient Storage. *International Journal of Bio-Resource and Stress Management*, **8(2):** *Punjab Agricultural University* **42:** 28–33.

Singh, M., A. Jasrotia, P. Bakshi, R.A. Shah, R. Kumar and M.I. Jeelani (2017). Influence of Different Postharvest Calcium Treatments and Storage Conditions on Quality of Peach cv. Shan-e-Punjab. *Int. J. Curr. Microbiol. App. Sci.*, **6(12):** 2459-2466.

Supapvanich, S. and S. Promyou (2013). Efficiency of salicylic acid application on postharvest perishable crops. In *Salicylic Acid* (pp. 339-355).

Yadav, S., S.K. Bhatia, R.K. Godara and G.S. Rana (2001). Effect of growth regulators on the yield and quality of winter season guava cv. L-49. *Haryana J. Hortic Sci.,* **30:** 1-2.