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RESEARCH PAPER

Effect of pre-harvest and post-harvest treatments on physico-chemical characteristics and shelf-life of guava fruits (*Psidium guajava* L.) during storage

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SUMMARY : The physico-chemical characteristics and shelf-life of guava fruits treated with 2.0 per cent calcium chloride, 2.0 per cent calcium nitrate, 1000 ppm copper oxychloride and distill water were studied. All tested treatments indicated a significant changes in weight loss, total soluble solids, non-reducing, reducing, total sugars, pectin and rotting percentage in guava fruits of experimental set that that of the control set. Moreover, the physicochemical analysis of guava fruits of experimental set revealed that it also contain higher amount of pectin content. The significant impact of treatment is found on the least rotting percentage in the order of fruits treated with calcium nitrate 2.0 per cent and calcium chloride 2.0 per cent. Hence, it could be concluded that post-harvest chemical treatment with calcium nitrate has the potential to control rotting incidence, prolong the shelf-life and preserve valuable attributes of post-harvest guava, presumably because of its effect on inhibition of ripening and senescence process.

KEY WORDS : Guava, Post-harvest treatments, Shelf-life, Physico-chemical

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Guava (*Psidium guajava* L.) is one of the most important, highly productive, delicious and nutritious fruit gown commercially throughout tropical and subtropical region of India. It occupies fifth position in terms of area and fourth position in terms of production among fruits of India. In M.P. the area under guava fruit is 4800 ha and production is about 95,000 MT (NHB, 2009). Though, successfully grown all over the country, Uttar Pradesh, Bihar, and Madhya Pradesh are the largest growers and produces best quality guava. Allahabad has the distinct reputation of growing best quality guavas in the world.

It is climacteric fruit and highly perishable in nature and should be marketed immediately after harvest; it can only be stored up to 2 to 3 days under ambient conditions. In order to minimize these losses and to quality of fruits during storage, the study was carried out to evaluate the efficacy of different chemicals on qualitative characters of the guava fruits.

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EXPERIMENTAL METHODS

The present investigation of pre and post-harvest application of different chemicals effect on shelf-life of guava fruits was conducted during January 2007 to April 2008. The treatments consisted of 20 combinations of pre-harvest spray (5 levels) and post-harvest dip (4 levels) comprising three replications were tested under Factorial RBD.

Pre-harvest spray treatment :

Single spray of calcium chloride 2 per cent (A_1), calcium nitrate (A_2), starch (A_3) and copper oxychloride (A_4) were carried out one month before harvesting in the first year on 10th December 2007 and in the second year on 2nd December 2008 with the help of foot sprayers using 0.1 per cent teepol as surfactant. The control trees were sprayed with distilled water

(A_0). The fruits were handled for sampling 30 days after spraying the chemicals (Bhanja and Lenka, 1994).

Post-harvest dip treatment :

Fruits of guava were harvested at jelly – making stage of maturity, *i.e.* neither under-ripe, nor over-ripe. Harvested fruits were selected and they have been sorted out to eliminate bruised, punctured and damaged one. The post-harvest treatments were carried out as per completely randomised block design with three treatments (T) *viz*., (i) Calcium chloride 2 per cent - (B_1), (ii) calcium nitrate 2 per cent - (B_2), (iii) copper oxychloride 1000ppm - (B_3) and control (treated with water) - (B_1). Each of these treatments was given by dipping the fruits of each set 2 min.

The treated fruits were stored for experimentation in room temperature and observation was recorded at 3 days interval upto 9th day storage condition on following physicochemical analyses.

Physiological Loss of Weight (PLW) (%) :

The PLW of guava fruit samples was calculated by considering the differences between initial weight and final weight of currently tested guava fruits divided by their initial weight.

Rotting (%) :

It was recorded by eye estimation from the numbered fruits of each experimental lot at each date of observation and the Disease Reduction Index (DRI) was calculated as suggested by Gutter (1969).

Shelf-life :

The shelf-life of these guava fruits was calculated by counting the days required for them to attain the last stage of ripening, but up to the stage when they remained still acceptable for marketing.

Total soluble solid (TSS) of the sample :

The total soluble solids of the fruit juice were determined by using Zeis Refractrometer of 0-30 per cent range (Atago Co., Tokyo, Japan). Homogenous sample of flesh was prepared after crushing the fruits. The sample was thoroughly mixed and a few drops were taken on refractometer and direct reading was taken by reading the scale in meter as described in AOAC (1984).

Chemical analysis :

The reducing and non-reducing sugar contents were determined by following the dinitrosalicylic acid method, while the anthrone method was followed for the total soluble sugars. The Pectin was determined by its extraction and saponified with alkali and precipitated as calcium pectate from an acid solution by addition of calcium chloride. The calcium pectate precipitate was washed until free from chloride dried and weighed.

Statistical analysis :

The experiment was laid out in a factorial randomized design with 3 replications. The data were analysed by null method as per Fisher (1958), Panse and Sukhatme (1978) and Gomez and Gomez (21984). Least significant difference at 5 per cent level was used for finding the significant differences among the treatment means.

EXPERIMENTAL FINDINGS AND ANALYSIS

The experimental findings of the present study have been presented in the following sub heads:

Effect on physical properties :

Physiological loss of weight :

Lowest loss in fruit weight was recorded with pre-harvest spray and post-harvest dip in 2.0 per cent calcium nitrate solution (A_2 B_3) followed by 2.0 per cent pre-harvest spray of 2.0 per cent starch (potato) and post-harvest dip in calcium nitrate solution during both years and average value of losses in fruit weight were increased with increase in time of spray and dip at after harvest. Highest losses in fruit weight was recorded with control treatment (distilled water spray alone) either pre-harvest or post-harvest dip (A_0 B_1). There was no significant difference between control (A_0 B_1) and pre-harvest spray of 2.0 per cent calcium chloride and post-harvest dip of copper oxychloride (A_1 B_1) (Table 1).

Table 1 : Effect of pre-harvest spray and post harvest dip of different chemicals on loss in fruit weight during storage (%)

Tr	3 DAH				6 DAH				9 DAH			
	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4
A_0	5.77	5.3	4.97	4.95	9.51	9.27	9.13	8.58	13.14	13.12	12.96	12.36
A_1	5.91	4.01	3.95	4.97	9.31	7.5	7.85	8.36	13.55	11.25	11.06	10.43
A_2	5.46	3.86	3.41	4.64	9.31	7.46	6.67	8.35	13.16	10.53	9.18	11.39
A_3	4.74	4.34	3.53	5.22	8.56	8.2	6.98	8.8	10.78	11.94	10.5	11.78
A_4	5.5	4.5	4.16	5.18	9.21	8.49	7.28	9.05	12.54	10.51	11.04	11.77
S.E.$\pm$	0.25				0.5				0.83			

The increase in physiological loss with the increased period of storage is obvious as during storage evapo-transpiration of moisture take place which causes reduction in physiological parameter. The reduction in physiological losses with application of calcium nitrate can be attributed to retardation in the rate of respiration and decay if any and to prevent cellular disintegration by maintaining protein and nucleic acid synthesis.

Rotting (%) :

Application of calcium compounds, starch and copper has significantly affected the rotting percentage of guava fruit at harvesting up to 9th day of storage period. Storage period in guava fruits was determined in this investigation (Table 2).

Minimum fruit rotting (18.48%) was recorded in A_2B_2 in comparison to A_0B_1 (80.92%) control. The decrease in ripening rate with calcium nitrate might be due to reduction in endogenous substrate catabolism (respiratory rate) by limiting the diffusion of substrates from the vacuole to cytoplasm. Higher concentration of calcium compounds significantly increased firmness in guava fruit (Sharma *et al.* 1996). This observation is in close proximity with the finding of Hiwale and Singh (2003) in guava fruit and Gautam *at al.* (2003) in mango and Mahajan and Chopra (1998) in red delicious apple.

Shelf-life (days) :

The data (Table 3) showed that the pre-harvest spray of 2.0 per cent calcium nitrate solution and post-harvest dip in 2.0 per cent calcium nitrate solution recorded highest (9.22, 9.37 and 9.30 in 2007, 2008 and average, respectively) shelf-life of guava fruits followed by pre-harvest spray of 2.0 per cent starch (potato) solution and post-harvest dip in 2.0 per cent calcium nitrate solution (8.32, 8.48 and 8.40 days in 2007, 2008 and average, respectively). The lowest values of shelf-life of guava fruit were recorded with pre-harvest spray of distilled water and post-harvest dip in any treatments.

Calcium is relatively divalent cation that readily enters the apoplastic and is bound in exchangeable form to cell wall and exterior surface of plasma membrane. Non-toxic even at high concentration, it serves as a detoxifying agent, tying up toxic compounds and maintaining the cation-anion balance in the vacuole. In the cell walls calcium serves as a binding agent in the of calcium pectates. Calcium has received considerable attention in the recent past due to its desirable effect. Particularly it can delay ripening and senescence, increases firmness, vitamin C and phenolic contents, reduces respiration, extends storage life and reduces the incidence of physiological disorders and storage rottage. Similar results were reported by Rajput *et al.* (2008) in guava and Ramkrishna *et al.* (2001) in papaya.

Table 2 : Effect of pre-harvest spray and post harvest dip of different chemicals on rotting of guava fruit after 9 days of storage (%)

Factor	2007				2008				Average			
	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4
	After 9 days storage											
A_0	81.58	73.17	69.35	74.89	80.27	74.39	69.84	74.66	80.92	73.78	69.59	74.77
A_1	37.82	37.63	34.50	38.77	40.17	30.83	32.98	39.41	39.00	34.23	33.74	39.09
A_2	43.75	17.03	20.06	21.48	38.67	19.93	21.58	31.18	41.21	18.48	20.82	26.33
A_3	38.27	24.58	24.69	33.09	37.28	38.51	23.50	36.40	37.78	31.55	24.10	34.75
A_4	52.07	45.65	41.35	46.44	61.14	58.98	48.62	55.67	56.61	52.31	44.99	51.05
S.E.±	1.60				1.73				1.24			
C.D.5 %	3.23				3.50				2.51			

Table 3 : Effect of pre-harvest spray and post harvest dip of different chemicals on shelf life of guava fruit after 9 days of storage (days)

Tr	2007				2008				Average			
	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4
	After 9 days storage											
A_0	4.39	4.99	5.84	5.86	4.56	5.17	5.98	6.02	4.47	5.08	5.91	5.94
A_1	6.01	6.15	6.58	6.26	6.16	6.31	6.72	6.41	6.09	6.23	6.65	6.34
A_2	6.81	7.37	9.22	7.34	6.93	7.55	9.37	7.49	6.87	7.46	9.30	7.42
A_3	6.25	7.40	8.32	6.56	6.42	7.59	8.48	6.73	6.33	7.49	8.40	6.64
A_4	4.96	7.08	7.22	6.51	5.13	7.25	7.36	6.67	5.05	7.16	7.29	6.59
S.E.±	0.29				0.29				0.29			
C.D.5%	0.59				0.58				0.58			

Table 4 : Effect of pre-harvest spray and post harvest dip of different chemicals on chemical properties of fruits

actor	3 DAH				6 DAH				9 DAH			
	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4	B_1	B_2	B_3	B_4
TSS (%)												
A_0	9.99	9.95	10.44	10.01	10.32	10.35	10.82	10.37	8.39	8.42	8.86	8.71
A_1	11.58	12.38	11.28	11.07	11.92	12.74	11.65	11.43	9.91	10.84	9.72	9.45
A_2	12.12	12.45	13.22	12.35	12.52	12.84	13.61	12.74	10.59	11.11	11.61	10.77
A_3	12.67	12.80	12.84	11.61	12.91	13.18	13.20	11.98	10.97	11.16	11.36	9.99
A_4	12.69	12.26	12.15	12.13	13.10	12.67	12.55	12.50	11.02	10.71	10.61	10.57
S.E.±		0.29				0.30				0.30		
C.D. 5%		0.59				0.61				0.61		
Reducing sugar (%)												
A_0	3.65	3.56	3.64	3.57	3.97	3.83	3.93	3.85	3.48	3.41	3.46	3.46
A_1	4.14	4.37	4.19	4.04	4.42	4.85	4.56	4.33	4.01	4.36	4.13	3.82
A_2	5.06	5.47	5.52	4.81	5.37	5.68	5.78	5.10	4.69	4.88	5.58	4.66
A_3	4.57	4.89	4.34	4.62	4.87	5.16	4.57	4.97	4.40	4.91	4.10	4.58
A_4	4.58	4.69	4.39	4.49	4.84	4.97	4.59	4.80	4.44	4.51	4.24	4.21
S.E.±		0.17				0.17				0.17		
$C.D._{5\%}$		NS				NS				0.35		
Non- reducing sugar (%)												
A_0	5.36	5.33	5.64	5.63	5.65	5.56	6.00	5.88	4.90	4.81	5.29	5.14
A_1	5.73	5.95	6.18	5.86	6.03	6.26	6.47	6.11	5.31	5.49	5.76	5.36
A_2	6.33	6.83	6.90	6.83	6.65	7.13	7.20	7.24	5.88	6.39	7.13	6.47
A_3	6.24	6.52	6.15	5.89	6.57	6.81	6.42	6.22	5.78	6.05	5.70	5.49
A_4	6.05	5.98	5.93	5.96	6.37	6.28	6.34	6.22	5.62	5.51	5.65	5.46
S.E.±		0.14				0.17				0.17		
C.D.5%		0.29				NS				0.34		
Total sugars (%)												
A_0	8.69	8.52	8.95	8.92	9.35	9.23	9.64	9.54	7.67	7.45	7.69	7.89
A_1	9.55	9.98	10.04	9.55	10.22	10.60	10.68	10.09	8.48	8.79	8.85	8.21
A_2	10.74	11.94	12.11	11.29	11.41	12.54	12.69	11.92	9.58	10.89	12.51	10.06
A_3	10.44	11.11	10.12	10.12	11.08	11.77	10.76	10.79	9.29	9.83	8.93	9.00
A_4	10.24	10.32	9.95	10.10	10.89	10.92	10.57	10.71	9.00	9.08	8.71	8.92
S.E.±		0.27				0.26				0.29		
C.D.5%		0.54				0.53				0.59		
Pectin (%)												
A_0	0.65	0.76	0.74	0.74	0.57	0.68	0.66	0.66	0.42	0.54	0.52	0.52
A_1	0.85	0.78	0.98	0.97	0.78	0.71	0.91	0.89	0.63	0.57	0.77	0.75
A_2	1.00	0.93	1.22	0.99	0.92	0.85	1.16	0.91	0.78	0.71	1.14	0.76
A_3	0.80	0.90	1.10	0.83	0.72	0.82	1.14	0.75	0.58	0.68	0.99	0.61
A_4	0.83	0.84	0.78	0.72	0.77	0.73	0.76	0.65	0.62	0.58	0.61	0.51
S.E.±		0.08				0.08				0.07		
C.D.5%		NS				NS				NS		

NS- Non- significant

Effect on chemical properties :

The fruit quality traits in terms of chemical properties such as total soluble solids, reducing sugars, non reducing sugars, total sugars, titratable acidity, pectin and ascorbic acid content were determined in this investigation.

TSS :

The statistically analyzed data presented in Table 4 showed that the different treatments significantly influenced the total soluble solids. It is observed that spray of 2 per cent calcium nitrate solution either pre-harvest of fruit or post-harvest dip in 2 per cent calcium nitrate solution recorded highest total soluble solids (13.22, 13.61 and 11.61 per cent at 3DAH, 6DAH and 9DAH, respectively) followed by 2.0 per cent pre-harvest spay of starch (potato) solution and post-harvest dip in 2.0 per cent calcium nitrate solution (12.84, 13.20 and 11.36 per cent at 3DAH, 6DAH and 9DAH, respectively). The total soluble solids were increased with increase in time of spray and dip at after harvest. Lowest total soluble solids was recorded with control treatment (distilled water spray alone) either pre-harvest or post-harvest dip (A_0 x B_1). There was no significant difference between A_0 x B_1 and pre-harvest spray of 2.0 per cent calcium chloride solution and post-harvest dip control treatment (distilled water) (A_1 x B_1).

Reducing sugar :

The data on reducing sugar of fruit in relation to different treatment are presented in Table 4. The data showed linearly significant effect of different treatment on reducing sugar at 9 days after harvesting. Remaining stages data showed irregular affect on stages-wise. It is observed that highest value of reducing sugar 5.58 per cent (A_2 B_3) was recorded with either pre-harvest spray of 2 per cent calcium nitrate solution and post-harvest dip in 2 per cent calcium nitrate solution. The lowest values of reducing sugar were recorded with pre-harvest spray of distilled water and post-harvest dip in any chemical compounds.

Non- reducing sugar :

The data on non reducing sugar of fruit in relation to different treatment are presented in Table 4. The data showed significant effect of different treatment on reducing sugar at all the stages of fruits after harvesting. Only average data at 6 days after harvesting showed non significant response. It is observed that highest value of non reducing sugar under either pre-harvest spray or post-harvest dip in 2.0 per cent calcium nitrate solution 6.90, 7.20 and 7.13 per cent was recorded at 3 DAH, 6 DAH and 9 DAH, respectively. The lowest values of non reducing sugar were recorded with pre-harvest spray of distilled water and post-harvest dip in any chemical compounds.

Total sugars :

The perusal of data (Table 4) revealed that spray of 2 per cent calcium nitrate solution either pre-harvest of fruit or post-harvest dip in 2 per cent calcium nitrate solution recorded highest total sugar (12.11, 12.69 and 12.51 per cent at 3DAH, 6DAH and 9DAH, respectively) followed by 2.0 per cent pre-harvest spay of calcium nitrate and post-harvest dip in 2.0 per cent calcium chloride solution during both years and average value. The total sugar increased with increases in time up to 6 DAH. Lowest total sugar was recorded with control treatment (distilled water spray alone) and post-harvest dip in 2.0 per cent calcium chloride (A_0 x B_2).

Pectin :

The highest pectin content was recorded under pre-harvest spray and post-harvest dip of calcium nitrate 2 per cent. Lowest pectin content was obtained under pre-harvest spray and post-harvest dip in distilled water (Table 4). The results confirm the finding of Bramhachari *et al.* (1997) and Rajput *et al.* (2008). This is also in agreement with the report of Raese and Drake (2000) in pear and Gautam *et al.* (2003) in mango.

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