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Edible coatings on storage behaviour of guava Cv. Lucknow – 49 under cold storage

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Abstract
Psidium guajava L. var. 'Lucknow-49' is a perishable fruit with delicate skin which is prone to damage. The objective of this study was to determine the effect of edible coatings made up of putrescine, chitosan, chitosan nano particles, *aloe vera, aloe vera* nano particles, zinc oxide and wax under cold storage. Coating solution was applied over fruits and coated fruits were stored at 8 ± 1 °C. Changes in physiological and bio chemical content were studied during post-harvest ripening. Among all the treatment T_7 (*Aloe vera* – 10 %) recorded significantly higher firmness (1.91 kg/cm^2), TSS (12.67 ºB) and titratable acidity (0.30 %) and lower up to 25th day of storage compared to other edible coatings as compared to other treatments. It can be conclude that use of 10 per cent *aloe vera* gel can improve the shelf life of guava fruits in ambient condition up to 25 day.

Keywords: edible coating, fruit storage, *Aloe vera*, nano particle and shelf life

Introduction
Guava (*Psidium guajava* L.) is very important fruit crop of the subtropical as well as tropical regions of the world. It is usually known as 'Apple of Tropics'. Inspite of being an introduced crop in India, considerable genetic diversity of guava is available in Indogangetic plains (Rajan *et al*., 2007) [14]. India is the world's largest producer of guava followed by China, Thailand, Indonesia, Pakistan, Mexico, Brazil, Bangladesh, Nigeria, Philippines, Vietnam, Kenya and Egypt (FAO, 2011) [5]. Although, it is very rich nutritionally, still world trade of guava fruits is limited owing to its highly perishable nature, limited post-harvest life and susceptibility to chilling injury (Rai *et al*., 2010) [13]. Due to perishable nature, its fruits undergo rapid post-harvest ripening in under ambient conditions (Bashir and Abu-Goukh, 2003) [1]. The guava, being a climacteric fruit exhibit respiratory and ethylene peaks during ripening. Owing to high metabolic activities there is rapid degradation of quality of guava fruits during storage. To reduce respiration rate, ethylene production and to extend the post harvest life, cold storages are widely used for fruits crops (Fattahi *et al*., 2010) [6]. Under ambient conditions, the fruits of guava become overripe and mealy within few days, while, under cold storage, the shelf life can be extended up to two weeks at 6-8 °C and 90-95% RH (Tandon *et al*., 1989) [17]. However, uncongenial storage conditions may result in accumulation of fermentative metabolites, which cause development of off-flavors rendering unacceptability of fruits to the consumer (Beaudry, 1993) [2]. Hence, immediate marketing and utilization of guava fruits after harvesting is generally practiced in India. Studies have shown that we can increase the longevity of harvested fruits by following different strategies i.e. the use of antitranspirants (Chahal and Bal, 2003) [3], wax coatings (Mahajan *et al*., 2005) [7], ethylene inhibitor & irradiation (Pandey *et al*., 2010) [10]. There are many techniques meant for enhancing the post-harvest life of fruits with the aim at reducing the respiration rate and thereby the catabolism.

Material and Methods
The lab investigation was conducted in Department of Horticulture, UAS, Dharwad during 2016 – 17. The experiment was conducted in Completely Randomized Design (CRD), comprising of 13 treatments with three replications and in each replication twenty five fruits were randomly selected. The fruits of uniform size, shape and maturity were harvested in the morning hours. The harvested fruits were brought to the laboratory of the Department of Horticulture for further study.

These fruits were subjected to different dipping treatments for specific duration and air dried under electric fan. The treated fruits were kept at ambient temperature (8±1 ºC). The observations on fruit firmness and quality parameters like TSS and titratable acidity were recorded at an interval of 2 days. Observation recorded up to 25 days when the fruits were completely unfit for consumption.

Results and Discussion

At the end of storage period of 25 days in cold condition guava (cv. Lucknow – 49) fruits treated with 10 per cent wax noted minimum PLW (2.70 %) which is on par with T_7 (2.79 %), T_6 (2.92 %) and T_8 (2.94 %). On contrary, maximum PLW is found to be associated with untreated fruits (3.78 %). The minimum firmness is observed in control T_{13} (1.15 kg/cm^2). Correspondingly, the highest firmness is registered in T_{12} (2.11 kg/cm^2), followed by T_7 (1.95 kg/cm^2) and T_6 (1.88 kg/cm^2) at the end of 25 days of cold storage. This might be due to wax emulsion forms a layer of thin coating on the surface of the fruit thereby blocks the lenticels partially and reduces the rates of respiration (Oliveira *et al*., 2000) [9] and transpiration (Chitarra and Chitarra, 2005) [4].

The significantly minimum value for TSS is recorded in T_{13} (10.96 and 9.70 ^{0}B) after 20 and 25 days of cold storage, respectively. On the contrary, the highest TSS is noticed in T_7 (14.24 and 12.61 0B), which is statistically on par with T_{12} (14.19 and 12.44 ^{0}B), T_8 (14.18 and 12.43 ^{0}B) and T_6 (13.98 and 12.02 ^{0}B) after 20 and 25 days of cold storage, respectively. Guava fruits treated with *Aloe vera* gel were able to maintain good taste as ethylene production was reduced in coated fruits which were due to reduction in ripening process created by modified atmosphere. Surface coating has been reported to increase resistance of fruit skin to gas permeability and reducing the respiration rate which was able to maintain a better taste. The above results are supported by the findings of Marpudi *et al*. (2011) [8] in *Aloe vera* gel coated papaya fruits.

After 25 days of cold storage the significantly minimum titratable acidity is recorded in the untreated fruits (0.10 %). The treatment T_7 (0.31 %) showed the maximum titratable acidity, followed by T_8 (0.26 %). The decrease in the acidity in the fruits during the storage is because of the fact that organic acid might be utilized rapidly in respiration or conversion of acid into sugar. These results are parallel to the findings of Sihag *et al.* (2005) [15] in peach; Paull (1982) [12] in soursop; Tuwar and Ugreja (1999) [18], Patel *et al.* (2011) [11] and Swati and Bisen (2012) [16] in custard apple and Mahajan *et al.* (2005) [5] in kinnow.

Table 1: Impact of edible coatings on physiological loss in weight and firmness of guava fruits Cv. Lucknow-49 under cold storage (8±1 ºC)

Treatments	Physiological loss in weight (%)						Firmness (kg/cm^2)					
	Storage period (Days)											
	0	5	10	15	20	25	0	5	10	15	20	25
T_1: Putrescine 1mM	0.00	0.57	1.31	1.64	2.31	2.99	7.36	7.20	5.35	3.71	2.69	1.54
T_2: Putrescine 3mM		0.63	1.38	1.78	2.43	3.21		7.11	5.21	3.48	2.39	1.33
T_3: Chitosan 1 %		0.61	1.36	1.70	2.38	3.15		7.15	5.26	3.58	2.47	1.39
T_4: Chitosan 2 %		0.54	1.27	1.61	2.27	2.95		7.22	5.38	3.77	2.73	1.61
T_5: Chitosan ZnO NP's 0.1 %		0.59	1.34	1.67	2.35	3.08		7.18	5.31	3.66	2.57	1.47
T_6: *Aloevera* 5 %		0.45	1.13	1.50	2.11	2.88		7.27	5.46	3.93	2.96	1.84
T_7: *Aloevera* 10 %		0.41	1.07	1.41	1.99	2.76		7.28	5.53	4.09	3.00	1.91
T_8: *Aloevera* ZnO NP's 0.1 %		0.46	1.15	1.50	2.13	2.90		7.25	5.45	3.91	2.94	1.80
T_9: ZnO Bulk 0.1 %		0.51	1.23	1.57	2.21	2.98		7.14	5.41	3.87	2.88	1.71
T_{10}: Chitosan ZnO 0.1%		0.68	1.45	1.91	2.60	3.41		6.95	5.12	3.38	2.21	1.20
T_{11}: *Aloevera* ZnO 0.1%		0.66	1.42	1.84	2.51	3.34		6.99	5.18	3.41	2.30	1.28
T_{12}: Wax 10 %		0.35	0.96	1.34	1.88	2.67		7.34	5.58	4.15	3.08	2.07
T_{13}: Control (Water dip)		0.73	1.54	2.24	2.81	3.71		6.44	4.88	2.99	2.03	1.14
Mean		0.55	1.28	1.67	2.31	3.08		7.12	5.32	3.69	2.63	1.56
S. Em.±		0.01	0.02	0.03	0.04	0.06		0.13	0.10	0.07	0.05	0.03
C. D. at 1%		0.04	0.10	0.13	0.17	0.23		0.51	0.38	0.27	0.19	0.11

Table 2: Impact of edible coatings on total soluble solids and titratable acidity of guava fruits Cv. Lucknow-49 under cold storage (8±1 ºC)

Treatments	Total soluble solids (ºB)						Titratable acidity (%)					
	Storage period (Days)											
	0	5	10	15	20	25	0	5	10	15	20	25
T_1: Putrescine 1mM	10.51	11.80	13.00	14.71	13.79	11.91	0.76	0.62	0.52	0.42	0.30	0.18
T_2: Putrescine 3mM		12.18	13.55	14.57	13.36	11.62		0.60	0.48	0.38	0.28	0.14
T_3: Chitosan 1 %		11.94	13.20	14.66	13.51	11.72		0.60	0.50	0.40	0.28	0.16
T_4: Chitosan 2 %		11.51	12.81	14.79	13.86	11.95		0.64	0.54	0.44	0.34	0.20
T_5: Chitosan ZnO NP's 0.1 %		12.02	13.08	14.84	13.70	11.81		0.62	0.50	0.42	0.30	0.18
T_6: *Aloevera* 5 %		11.42	12.58	14.87	14.05	12.08		0.68	0.60	0.50	0.36	0.24
T_7: *Aloevera* 10 %		11.13	12.00	15.44	14.32	12.67		0.72	0.64	0.54	0.40	0.30
T_8: *Aloevera* ZnO NP's 0.1 %		11.38	12.15	15.31	14.25	12.49		0.70	0.62	0.50	0.38	0.26
T_9: ZnO Bulk 0.1 %		11.51	12.49	15.19	14.21	12.36		0.66	0.56	0.46	0.36	0.22
T_{10}: Chitosan ZnO 0.1%		12.50	13.95	14.79	13.34	11.55		0.56	0.44	0.32	0.22	0.14
T_{11}: *Aloevera* ZnO 0.1%		12.47	13.87	14.83	13.33	11.65		0.58	0.46	0.36	0.26	0.16
T_{12}: Wax 10 %		11.37	12.25	15.19	14.26	12.50		0.68	0.58	0.48	0.36	0.24
T_{13}: Control (Water dip)		12.81	14.83	13.50	11.01	9.75		0.52	0.40	0.28	0.16	0.10
Mean		11.85	13.06	14.82	13.61	11.85		0.63	0.53	0.42	0.31	0.19
S. Em.±		0.22	0.24	0.27	0.25	0.22		0.01	0.01	0.01	0.01	0.01
C. D. at 1%		0.87	0.96	1.07	0.98	0.86		0.05	0.04	0.03	0.02	0.01

Conclusion

In conclusion, post harvest treatment of guava fruits with 10 per cent aloevera significantly delayed physico-chemical changes and registered maximum shelf life of 25 days as compared to control (15 days) under cold storage condition. The results of the present research revealed that the shelf life of guava fruits can be extended by coating with bio preservative like *aloe vera* gel to maintain physiological and physico-chemical changes leading to decay of fruits under cold storage. *Aloe vera* zinc nano particles (0.1 %) treatment of guava fruits also provides the best alternative for shelf life extension.

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