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Edible coatings on storage behaviour of guava cv. Lucknow-49 under ambient condition

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Abstract
Various viable technologies for improving the shelf life and marketability of horticultural commodities have evolved during the past decades, like use of various chemicals, fungicides, growth regulators, retardants, anti transpirants, wax coatings, different types of packing materials, modified and controlled atmosphere storage etc. Guava fruit is often referred to as 'apple of tropics' probably due to its high nutritive value similar to commercially important temperate fruit like apple. It is a rich source of vitamin 'C' and fair source of minerals. Guava has a short post-harvest shelf life of 5-8 days. Under ambient condition fruits ripen rapidly after harvest and are highly perishable. The fruit ripening in guava is characterized by loss of green colour, softening, shrinkage, loss of brightness and rotting. Different edible coating materials such as, putrescine, chitosan, *Aloe vera*, *Aloe vera* zinc nanoparticles, chitosan zinc nano particles, Zinc oxide, *Aloe vera* zinc particles, chitosan zinc particles, and fruit wax was applied to the surface of guava fruits. Among all the treatment T_7 (*Aloe vera* – 10%) recorded significantly higher firmness (3.83 kg cm^{-2}), TSS (14.80 ^{o}B) and titratable acidity (0.58%) upto 8th day of storage compared to other edible coatings as compared to other treatments. It can be conclude that use of 10 percent *Aloe vera* gel can improve the shelf life of guava fruits in ambient condition upto 12 day.

Keywords: Edible coating, fruit storage, *Aloe vera*, nanoparticle, shelf life

Introduction
Guava (*Psidium guajava* L.) is fifth most important fruit crop in India and grown widely in tropical and subtropical regions of the world for its nutraceutical value and delightful taste. In India it occupies 2.51 lakhs hectare area with a total production of 40.83 lakh tonnes and productivity of 16.27 tonnes per hectare [3]. High respiration rate and fast ripening of harvested fruits leads to its perishability during storage periods. In view of above facts, an attempt was made to study the effect of different postharvest treatments on quality and shelf life of guava.

Advances in the preparation of nanosystems that incorporate ingredients acceptable for food products have made it possible to explore the functional modifications of edible coatings that integrate nanoemulsions, polymeric nanoparticles, nanofibers, solid lipid nanoparticles, nanostructured lipid carriers, nanotubes, nanocrystals, nanofibers which allows greater control over the release of the edible coating active ingredients.

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 (28±1 °C). The observations on fruit firmness and quality parameters like TSS and titratable acidity were recorded at an interval of 2 days. Observation recorded upto 12 days when the fruits were completely unfit for consumption.

Results and Discussion
Measuring the firmness of a fruit is a quick, easy and accurate way to determine the quality and level fruit maturity. Fruit firmness decreased with advancement in storage in all treatments. The treatment T_7 (*Aloe vera* – 10%) recorded significantly higher firmness (3.83 kg cm^{-2}) followed by *Aloe vera* + Zn NP's (0.1%) compared to control (1.98 kg cm^{-2}) after 12

days of storage. The maintenance of firmness in the fruits treated with *Aloe vera* coatings could be due to covering of the cuticle and lenticels and their higher antifungal activity thereby reducing respiration, other ripening processes and infection during storage [25].

In the present study, in general all the postharvest treatments retained maximum firmness compared to uncoated fruits. However, guava fruits coated with 1 percent *Aloe vera* gel retained significantly maximum firmness. The maintenance of firmness by *Aloe vera* gel treatment might be due to the inhibitory effect on cell wall degrading enzymes. The softening process in fruit has been reported to be dependent on the increase in polygalacturonase, ß-galactosidase and pectin methyl esterase activities [18] being responsible for fruit quality loss but *Aloe vera* gel probably had some effects on the reduction of cell wall degrading enzymes. *Aloe vera* gel coating on pineapple [1], *Aloe vera* gel combined with papaya leaf extract on papaya [5] reduced the firmness loss. Previous reports have demonstrated that *Aloe vera* as an edible coating was a good postharvest tool to retard the postharvest ripening that resulting in loss of firmness of both climacteric and non-climacteric fruits such as table grape, sweet cherry, nectarine, peach, plum, papaya, tomato [25, 13, 2, 15, 11, 6, 8] as well as fresh-cut kiwifruit [4] and apple [7].

The TSS content of fruit was gradually increased upto 8th day storage in all the treatments but in *Aloe vera* (10%) treated fruits shown maximum TSS (12.10 ºB) after 12th days of storage. It was significantly on par with the treatment *Aloe vera* + Zn NP's - 0.1% (11.90 ºB). While untreated fruits shown lowest TSS (9.10 ºB). This might be due to *Aloe vera* coating retarded TSS development because of decrease in respiration and eventually metabolism of sugars [25].

Among the different treatments *Aloe vera* gel coated guava fruits significantly delayed the change in total soluble solids indicating a delay in ripening. *Aloe vera* leads to lower increase in TSS, which indicated slower ripening than the uncoated fruits which recorded early increase in TSS. This could be due to slower respiration and delayed ripening in *Aloe vera* coated guava fruits leading to slower conversion of polysaccharides into sugars. Further, the *Aloe vera* coating creates a modification of the internal atmosphere, showing similar effects as modified atmosphere packaging resulting in delayed ripening changes and sugar synthesis in fruits [13]. Similar results were reported in tomatoes [14], in fig [12] and in grapes [19].

The titratable acidity was relatively high at harvest and then it decreased with advancement in storage. Among all the treatments the acidity was lowest (0.22%) in the fruits treated with T_{13} (Water dip) whereas, fruits treated with *Aloe vera* (10%) retained the highest titratable acidity (0.38%) after 12 days of storage. This retention of titratable acidity content by *Aloe vera* was due to the protective effect of aloe gel coating as a barrier to oxygen from the surrounding atmosphere and reduction of respiration [21]. Gradual decrease in acidity has also been reported in kinnow [9]. Washington Novel orange fruits recorded lower level of ascorbic acid, TSS and acidity as they ripened [23].

In this study, titratable acidity of guava fruits decreased during the storage period in all the treatments. 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 in peach [20]; in soursop [17]; in custard apple [24, 16, 22] and in kinnow [10].

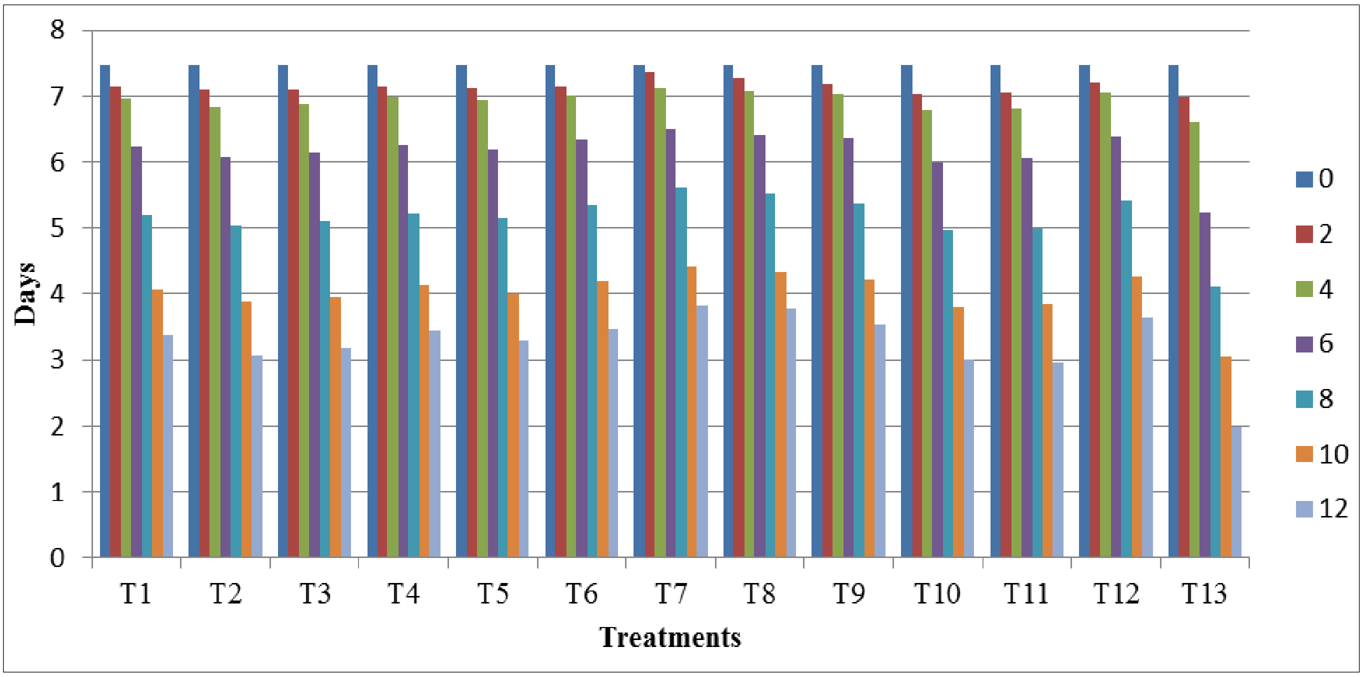

Fig 1: Impact of different edible coatings on Firmness (kg/cm^2) of guava cv. Lucknow-49.

Table 1: Impact of edible coatings on total soluble solids of guava cv. Lucknow-49 under ambient condition.

Treatments	TSS (ºB)						
	Storage period (Days)						
	0	2	4	6	8	10	12
T_1: Putrescine 1mM	9.58	11.24	12.35	13.80	14.00	13.10	11.30
T_2: Putrescine 3mM		11.52	12.80	14.16	13.80	12.65	11.00
T_3: Chitosan 1%		11.33	12.50	14.00	13.90	12.80	11.10
T_4: Chitosan 2%		11.00	12.20	13.70	14.10	13.20	11.35
T_5: Chitosan ZnO NP's 0.1%		11.31	12.40	13.93	14.10	13.00	11.20
T_6: *Aloe vera* 5%		10.83	12.00	13.50	14.20	13.40	11.50
T_7: *Aloe vera* 10%		10.60	11.40	12.80	14.80	13.70	12.10
T_8: *Aloe vera* ZnO NP's 0.1%		10.80	11.50	13.00	14.50	13.60	11.90
T_9: ZnO Bulk 0.1%		10.90	11.80	13.30	14.35	13.40	11.65
T_{10}: Chitosan ZnO 0.1%		11.65	13.00	14.35	13.85	12.50	10.80
T_{11}: *Aloe vera* ZnO 0.1%		11.65	12.95	14.20	13.90	12.50	10.90
T_{12}: Wax 10%		10.80	11.60	13.10	14.40	13.50	11.80
T_{13}: Control (Water dip)		11.90	13.80	14.80	12.70	10.30	9.10
Mean		11.19	12.33	13.74	14.05	12.90	11.21
S. Em.±		0.225	0.240	0.259	0.263	0.235	0.204
C. D. at 1%		0.888	0.940	1.023	1.042	0.930	0.808

Table 2: Impact of edible coatings on titratable acidity content of guava cv. Lucknow-49 under ambient condition.

Treatments	Titratable acidity (%)						
	Storage period (Days)						
	0	2	4	6	8	10	12
T_1: Putrescine 1mM	0.76	0.66	0.54	0.46	0.38	0.32	0.26
T_2: Putrescine 3mM		0.62	0.52	0.42	0.34	0.28	0.26
T_3: Chitosan 1%		0.64	0.52	0.44	0.36	0.28	0.26
T_4: Chitosan 2%		0.68	0.54	0.48	0.40	0.32	0.28
T_5: Chitosan ZnO NP's 0.1%		0.66	0.52	0.44	0.38	0.30	0.26
T_6: *Aloe vera* 5%		0.68	0.56	0.48	0.36	0.32	0.28
T_7: *Aloe vera* 10%		0.74	0.64	0.58	0.42	0.40	0.38
T_8: *Aloe vera* ZnO NP's 0.1%		0.72	0.60	0.52	0.40	0.36	0.32
T_9: ZnO Bulk 0.1%		0.70	0.56	0.48	0.38	0.34	0.30
T_{10}: Chitosan ZnO 0.1%		0.60	0.50	0.40	0.30	0.26	0.24
T_{11}: *Aloe vera* ZnO 0.1%		0.62	0.50	0.42	0.32	0.28	0.26
T_{12}: Wax 10%		0.72	0.60	0.50	0.38	0.34	0.32
T_{13}: Control (Water dip)		0.58	0.46	0.40	0.28	0.26	0.22
Mean		0.66	0.54	0.46	0.36	0.31	0.28
S. Em.±		0.010	0.010	0.009	0.007	0.006	0.006
C. D. at 1%		0.050	0.040	0.034	0.026	0.023	0.022

Conclusion

In conclusion, post harvest treatment of guava fruits with 10 per cent *Aloe vera* significantly delayed physico-chemical changes and registered maximum shelf life of 12 days as compared to control (7.00 days) under ambient 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, physico-chemical changes leading to decay of fruits under ambient 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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