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Bee wax, Aloe vera gel and Carnauba wax impact on chemical shelf life of guava fruits under ambient storage conditions

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Abstract
Shelf life is a limiting factor in fruits during storage. The guava fruits have a very less storage shelf life. The chemical changes during storage in an important aspect that influence the quality of fruit. So slower changes in the chemical properties of guava fruit can help to extend the shelf life of fruit. Fruit coating helps in reduce evaporation, respiration rate and protects against biotic and abiotic stresses to fruits. In the experiment different concentrations (5%, 10% and 15%) of three edible coating materials (Aloe vera, bee wax and carnauba wax) and their combination, 10% each compared with control in which fruit were not treated with any material. The experiment was designed with CRD with three replication under ambient storage conditions. Results revealed that among all the treatments, bee wax 10% slower the changes in TSS, acidity and ascorbic acid up to 20 days, while the individual coating of carnauba and Aloe vera in guava fruits were spoiled after 10-15 days after storage. Mixed coating of bee wax, carnauba and Aloe vera 10% each can also be recommended for guava fruits.

Keywords: Guava, Aloe vera, ascorbic acid, coating, carnauba wax, weight, bee waxes etc.

Introduction

Guava (*Psidium guajava* L.) has botanically known as "Apple of Tropics" and poor man apple (Dutta *et al*., 2017) [4]. It is one of the most important subtropical and tropical fruit crops in world as well as India. Guava have relative short storage shelf life due to fastest ripening process and chilling sensitive nature (Yamanur *et al.*, 2021) [11]. Guava is highly perishable fruit need to be disposed of immediately after harvest. Lack of facilities and improper storage conditions causes 20-25% losses of guava fruit by completely damaged and spoiled before it reaches to the consumer (Einstein Mathias de Medeiros Teodosio *et al*., 2018) [5]. Losses during post-harvest operations due to improper storage and handling are enormous and can range from 20-50 percent in developing countries (Rehman *et al*., 2020) [8]. Because of high moisture content, horticultural crops are inherently more liable to deteriorate especially under tropical conditions (Raghav *et al*., 2016) [12]. During peak seasons when horticultural crops arrive in plenty at the market, prices slump bringing the farmer less profit. Every crop is worthy of its investment only when it is utilized completely without losses (Sahoo *et al*. 2014) [7].

The low quality of fruits reduces consumer acceptability drastically in the market (Yadav *et al*, 2014). The Post-harvest losses of fruits are a most serious concern because it rapidly deteriorates during handling, transport and storage. Edible coatings over fruits are used to improve their shelf life (Beulah *et al*., 2021). The main purpose and objective of edible coating for fruits is basically to increase the natural barrier, if already present and to replace it in the cases where handling and washing have partially removed or altered it. Furthermore, one of the most important elements of this edible coating is the fact that they can be eaten together with fruits. The ripe fruit has attractive color, shape and size, rich flavor, pleasant aroma, excellent taste, sweet and fibreless flesh. It also has excellent sugar: acid blend (Yadav *et al*., 2013) [9, 10].

The edible coatings establish a modified atmosphere around the product, and act as a barrier hindering O_2 and CO_2 diffusion, water vapor and aroma compounds, decreasing the respiration rate of the fruit and water loss and preserving texture and flavor (Olivas *et al*., 2008) [9, 10]. Edible coating helps to delay the ripening of climacteric fruit, reduce water loss, decay and improve its appearance. It is necessary to develop less expensive methods of storage that are convenient, economical and within the reach of a common grower or trader (Chaudhary *et al*., 2019) [3].

Material and Methodology

The current research work was conducted in School of Agriculture Lovely Professional University, Phagwara, Punjab during 2021-22. Fresh guava fruits were purchased from the nearby local orchard. Bee wax, aloe vera gel and carnauba wax was collected from the University laboratory. Bee wax, Aloe vera and carnauba wax were made at 5%, 10% and 15% concentrations. Emulsion were made by heating with 100 ml oleic acid and 840 ml of distilled water. The fruits were dipped in the solution at ambient temperature for 1 minute and kept for 24 hours for dry.

Observations were recorded at 5 days interval up to 20 days on chemical parameters TSS (°B), ascorbic acid (%) and titratable acidity (%). The method used to measure parameters are as:

Total soluble solids (˚Brix): The TSS of ripe guava fruit juice was determined with the help of a hand refractometer (0-32 ⁰brix). The total soluble solids were expressed in per cent.

Titratable acidity (%): 10 ml of the fruit juice was taken in a 100 ml volumetric flask and the volume was made upto 100ml by adding distilled water. That fruit juice was titrated against 0.1 N NaOH. Then add 2 drops of phenolphthalein indicator. The end point was determined by the appearance of a faint pink color. Note down the readings of NaOH used and calculate using the formula as mentioned below:

$$\text{Titratable acidity (\%)} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{eq. wt. of acid} \times 100}{\text{Volume of sample taken} \times \text{wt. of sample taken} \times 100}$$

Ascorbic acid (mg/100g): It was determined as per standard A.O.A.C. method (A.O.A.C., 1980) [13] using 2, 6-dichlorophenol indophenols dye. The sample extracted in 3% m-phosphoric acid was titrated with the dye to an end point of pink color. Ascorbic acid was expressed as mg per 100 g of sample and calculated by using the following formula:

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{volume made up}}{\text{Aliquot taken} \times \text{weight of sample taken}} \times 100$$

Results and Discussion

Among all the treatments in control (T0) the fruits were spoiled after 10 days, while Aloe vera and Carnauba wax-coated fruits were spoiled after 15 days of coating guava fruits. Whereas, Bee wax coated and combined coated (T10) fruits were less spoiled and observed up to 20 days of coating fruits.

Total Soluble Solid (°B)

Changes in TSS of guava fruit after apply the different coating materials under ambient storage condition (Table 1). Changes in shelf life respect to TSS was significantly increased in different treatments. The highest shelf life with respect to TSS was observed in Bee wax coated fruits. Among the concentration of Bee wax, 10% gives highest shelf life where fruits TSS was ranged from (10.21 to 11.56 °B) followed by combined treatment (T10) ranged from (10.20 to 11.75 °B), 5% Bee wax (10.20 to 11.83 °B), 15% bee wax (10.21 to 12.55 °B) up to 20 days of storage. While least shelf life in respect to TSS was observed in Control (T0) i.e., (10.21 to 12.63°B) up to 10 days, followed by 15% carnauba wax (10.20 to 12.71 °B), 10% carnauba wax (10.21 to 10.93 °B), 5% Aloe vera gel (10.21 to 12.32 °B), 10% Aloe vera gel (10.21 to 12.25 °B), 15% Aloe vera (10.22 to 12.19 °B), 5% carnauba wax (10.20 to 12.05 °B) up to 15 days of storage under ambient condition.

The delay in TSS content upon coating application could be related with the oxygen barrier property of edible coating and reduction of respiration as a result. Similar observation was reported by Yonemoto *et al*. (2003) [15].

Titratable acidity (%)

The result in table 2 represent changes in acidity of guava fruit after apply the different coating materials under ambient storage condition. Changes in shelf life respect to acidity was significantly increased in different treatments. The highest shelf life in respect to acidity was observed in Bee wax-coated fruits. Among the concentration of Bee wax, 10% (T5) gives highest shelf life with least physiological weight loss in guava fruit. Where fruits acidity was ranged from (0.50 to 0.26%) followed by combined treatment (T10) ranged from (0.50 to 0.27%), 5% Bee wax (0.51 to 0.28%), 15% bee wax (0.51 to 0.28%) up to 20 days of storage. While least shelf life in respect to acidity was observed in Control (T0) i.e., (0.49 to 0.25%) up to 10 days, followed by 10% carnauba wax (0.50 to 0.37%),15% carnauba wax (0.50 to 0.39%), 5% carnauba wax (0.52 to 0.40%), 15% Aloe vera gel (0.51 to 0.42%), 10% Aloe vera gel (0.58 to 0.42%), 5% Aloe vera gel (0.55 to 0.44) up to 15 days of storage under ambient condition.

The titratable acidity decreased with increased storage time in all coated and control fruits. This could be as a result of respiration which utilizes organic acid as respiratory substrates. Doreyappa and Huddar (2001)

Ascorbic Acid (%)

The result in table 3 represent changes in ascorbic acid of guava fruit after apply the different coating materials under ambient storage condition. Changes in shelf life respect to ascorbic acid was significantly increased in different treatments. The highest shelf life in respect to ascorbic acid was observed in Bee wax-coated fruits. Among the concentration of Bee wax, 10% (T5) gives highest shelf life with least physiological weight loss in guava fruit. Where fruits ascorbic acid ranged from (276.50 to 196.40) followed by combined treatment (T_{10}) ranged from (276.47 to 190.99), 15% Bee wax (276.69 to 181.22), 5% bee wax (276.53 to 180.35) up to 20 days of storage. While least shelf life in respect to ascorbic acid was observed in Control (T_0) i.e., (276.55 to 190.74) up to 10 days, followed by 15% Aloe vera gel (276.54 to 193.43), 10% Aloe vera gel (276.48 to 192.37), 15% carnauba wax (276.73 to192.36), 10% carnauba wax (276.34 to 192.27), 5% Aloe vera gel (276.48 to 191.46), 5% carnauba wax (276.70 to 191.13) up to 15 days of storage under ambient condition.

The values of edible coated and uncoated guavas reduced significantly with storage period as depicted in Table II

Table 1: Effect of different levels of fruit coating on total soluble solid (%) of Guava fruit

Treatments	Storage Days				
	0 Days	5 Days	10 Days	15 Days	20 Days
T0 (Control)	10.21	11.54	12.63	0	0
T1 (5% Aloe vera gel)	10.21	10.52	10.67	12.32	0
T2 (10% Aloe vera gel)	10.21	10.55	11.31	12.25	0
T3 (15% Aloe vera gel)	10.22	10.59	11.29	12.19	0
T4 (5% Bee wax)	10.2	10.89	11	11.33	11.83
T5 (10% Bee wax)	10.2	10.73	10.97	11.29	11.56
T6 (15% Bee wax)	10.21	11.02	11.71	12.01	12.55
T7 (5% Carnauba wax)	10.2	10.62	11.23	12.05	0
T8 (10% Carnauba wax)	10.21	10.78	11.49	12.53	0
T9 (15% Carnauba wax)	10.2	10.82	10.89	12.71	0
T10 (10% Aloe vera gel + 10% Bee wax + 10% Carnauba wax)	10.2	10.69	11.08	11.49	11.75
C.D.	N/A	0.051	0.409	0.034	0.03
S.Em (±)	0.01	0.017	0.139	0.011	0.01

Table 2: Effect of different levels of fruit coating on acidity (%) on Guava fruit

Treatments	Storage Days				
	0 Day	5 Days	10 Days	15 Days	20 Days
T0 (Control)	0.49	0.38	0.25	0	0
T1 (5% Aloe vera Gel)	0.55	0.55	0.50	0.44	0
T2 (10% Aloe vera Gel)	0.58	0.51	0.49	0.42	0
T3 (15% Aloe vera Gel)	0.51	0.51	0.47	0.42	0
T4 (5%Bee wax)	0.51	0.50	0.45	0.38	0.28
T5 (10% Bee wax)	0.5	0.48	0.44	0.38	0.26
T6 (15% Bee wax)	0.51	0.49	0.45	0.39	0.28
T7 (5% Carnauba wax)	0.52	0.50	0.46	0.4	0
T8 (10% Carnauba Wax)	0.5	0.48	0.44	0.37	0
T9 (15% Carnauba Wax)	0.5	0.49	0.44	0.39	0
T10 (10%Aloe vera gel + 10% Bee wax + 10% Carnauba Wax)	0.53	0.53	0.50	0.41	0.27
C.D. (5%)	0.034	0.03	0.038	0.029	0.011
SE(m) **(±)**	0.012	0.01	0.013	0.01	0.004

Table 3: Effect of different levels of fruit coating on ascorbic acid (%) on Guava fruit

Treatments	Storage Days				
	0 Day	5 Days	10 Days	15 Days	20 Days
T0 (Control)	276.55	226.47	190.74	0	0
T1 (5% Aloe vera Gel)	276.48	251.62	221.58	191.46	0
T2 (10% Aloe vera Gel)	276.48	243.51	227.59	192.37	0
T3 (15% Aloe vera Gel)	276.54	252.08	227.84	193.43	0
T4 (5%Bee wax)	276.53	254.80	231.75	199.87	180.35
T5 (10% Bee wax)	276.5	258.70	235.92	211.95	196.4
T6 (15% Bee wax)	276.69	255.02	232.50	200.96	181.22
T7 (5% Carnauba wax)	276.7	250.53	223.92	191.13	0
T8 (10% Carnauba Wax)	276.34	251.31	222.54	192.27	0
T9 (15% Carnauba Wax)	276.73	251.04	221.31	192.36	0
T10 (10%Aloe vera gel + 10% Bee wax + 10% Carnauba Wax)	276.47	256.52	230.97	205.98	190.99
C.D. (5%)	N/A	7.58	2.96	0.88	0.71
SE(m) **(±)**	0.15	2.57	1.00	0.30	0.24

Conclusion

Edible-coated guavas were good for all quality parameters as compared to untreated guavas. This study comprised of postharvest treatments of bee wax shows the best results in all parameters after that most successful results are from a combined treatment of bee wax, Aloe vera and carnauba wax @ 10% each. Observations based on chemical parameters it is concluded that bee wax @ 10% coated fruits of guava was most useful for minimizing chemical changes in respect of TSS, Acidity and ascorbic acid up to 20 days of storage under ambient conditions. Therefore, the edible coating of bee wax 10% could be used effectively as it is an effective method for the enhancement of shelf life in guavas.

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