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Application of chitosan edible coating to guava to study quality parameters

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Abstract
Guava (*Psidium guajava* L.) is one of the most widely consumed fresh fruit in the world. Guavas were coated with 0.25 and 0.5% chitosan. The physico-chemical parameters were studied for a period of 30 days. The lower concentrations of chitosan 0.25% was found effective than 0.5% in maintaining the physico-chemical characteristics. The results clearly indicated that fruits treated with chitosan were better in maintaining all physicochemical characteristics (pH-4.60, TSS-9.40, Acidity-0.34, Ascorbic acid-208, Weight loss-14.87 and Moisture-73.37) than control throughout the storage period. The study concludes that chitosan coating could be a good alternative to preserve the quality and extend the post-harvest life of Guava.

Keywords: chitosan, shelf life guava, weight loss

Introduction

Guava is the most important fruit crop after mango, banana and citrus. It has been cultivated in India since early 17th century and gradually became a crop of commercial significance in India.

The Guava fruit ranges from round, ovoid, to pear-shaped, growing up to 2-5 in (5-12.5 cm) long. The thin skin varies in color from pale greenish to light-yellow, blushed with pink for certain cultivars. Underneath the skin is a layer of flavorful sweet and tangy flesh with color varying from white, yellowish, light pink, dark pink, or red. When immature, the fruit is green, tough, and very astringent. When ripe, some varieties have a custard-like consistency while others are crisp like an apple. The central pulp can be of the same color or darker than the surrounding flesh, is juicy and normally filled with very heavy, yellowish seeds.

Fruits are graded based on weight, size, and vividness. Fresh fruit has a short shelf life but can be extended up to 20 days when kept at low temperature of 5°C and 75-85% relative humidity. Good ventilation is necessary to reduce heat buildup. Guava is a delicate fruit requiring careful handling during harvesting and shipping. For long distance shipping, use of refrigerated transport and also proper packaging and cushioning material are required to enhance the shelf life of fruits.

Guava is one of the most delicious and nutritious fruit, liked by the consumers for its refreshing taste and pleasant flavor. It thrives well under all conditions because it can tolerate salinity as well as water logged conditions to some extent. Guava is generally broad, low calorie profile of essential nutrients, rich in dietary fiber, with moderate levels of folic acid and rich in minerals like phosphorus and iron and Vitamins like niacin, pantothenic acid, thiamine, riboflavin and vitamin-A. The fruit is an excellent source of ascorbic acid a single common guava fruit contains about four times the amount of vitamin-C has on orange.

The guava is usually green before maturity, but becomes yellow or maroon when ripe. The pulp inside may be sweet or sour and off-white (“white” guavas) to deep pink (“red” guavas). The sources in the central pulp vary in number and hardness, depending on species. As guava is highly perishable and has a limited postharvest shelf life up to 4-5 days that shows intense metabolic activity. Guava fruit becomes fully ripen in 3-5 days at room temperature from the day of harvest. Due to such portability; the control of fruit ripening is fundamental for increasing shelf life after harvest.

In many countries, guava is eaten raw. Some eat it with a touch of salt and pepper, cayenne powder or masala.

The refreshing fruit is a very beneficial source of vitamin C, pectin, calcium, and phosphorus. Due to the perishability, to extend the storage life and its importance in world agricultural trade, present study was planned to evaluate the effect of chitosan edible coating on shelf life of guava. Physicochemical parameters were analyzed periodically to understand the qualitative and quantitative changes in guava during the storage.

Materials and Methods

Materials

Fresh and mature guava (*Psidium guajava* L.) were collected from the local farmers with uniform size, shape, color, maturity and without any signs of mechanical damage or fungal decay. Chitosan was purchased from Sisco Research Laboratories and glacial acetic acid from Merck India Ltd.

Preparation of coat forming solution

The coating solution was prepared by dissolving 2.5 and 5 g of chitosan powder in 900 ml of distilled water, 50 ml of glacial acetic acid was added to dissolve the chitosan to prepare 1 L of 0.25%, 0.5% chitosan solutions (Jiang and Li, 2001) [9] and pH was adjusted to 5.0 with 0.1M NaOH and the solution was made up to 1L. The coating solutions was prepared and coded as control, 0.25% and 0.5% chitosan solutions. The acid solution of pH 5.0 without chitosan was prepared and used as control.

Application of coating

The surface of the fruits were disinfected with 4% chlorine (hypochlorite) for 3 min and gently rinsed with distilled water, then air-dried. Then they were dipped in the chitosan coat forming solution of 0.25% and 0.5% for 1 min and the samples were air dried for 30 min at room temperature (Approx 30°C). The coated fruits were packed in paper separately to avoid physical and microbial damage and kept at ambient temperature for a period of 30 days to study the shelf life and physico-chemical parameters.

Determining weight loss and moisture content

Three batches of guava containing 100-110g of whole guavas were taken at an interval of three days for total storage period. The guavas were weighed regularly to determine weight loss, which was calculated cumulatively by comparing the weights of the sample with the electronic weighing balance (Shimadzu- ELB300 NO: D515711067, Japan) at an interval of 3 days for the total 30 days storage period and the results were expressed as percentages. The moisture content was determined by the method (Williams, 1984).

Measurement of pH, total soluble solids, titratable acidity and ascorbic acid

The pH, total soluble solids (TSS) and titratable acidity (TA) have been determined by the methods followed by Islas-osuna *et al*. (2010) with slight modifications. 5 g guava pulp was homogenized in 25 ml of distilled water. Then the mixture was filtered using muslin cloth. An aliquot of 25 ml was used to measure pH with a pH meter (Eutech instruments, prod- ECPH70042SEU, Singapore). The TSS was measured directly from the filtered residue using a hand refractometer (Erma Inc. Tokyo, Japan) and expressed as brix0.The titratable acidity was determined with 0.1 N NaOH. guava pulp (3g) from fruit was homogenized using a mortar and pestle (grinder) and then centrifuged at 3500 rpm (Remi centrifuge, CE model, India) for 10 minutes; The supernatant phase was collected and analyzed to determine ascorbic acid content by 2,6-dichlorophenolindophenol titration (Williams, 1984).

Result and Discussion

Weight loss and Moisture content

Chitosan coatings controlled the weight loss of guava compared to control. After 30 days of storage, the weight loss of the 0.25% and 0.5% coated guavas were 14.87% (highest), 11.45% (lowest) respectively. The weight loss observed in control was due to the shrinkage of fruits by loss of moisture which was not observed in the coated fruits. The chitosan coating prevented the evaporation of moisture from coated guavas. There was a significant difference observed between the control and coated samples. The 0.25% coated guava showed better retention in moisture when compared with control and 0.5% coated guava at the end of the storage period.

Table 1: Weight loss of chitosan coated and uncoated guava samples

Storage period (Days)	Control (CC)	Chitosan 0.25 % (AC)	Chitosan 0.5% (BC)
3	2.50 ± 0.05 ^{f,A}	2.20 ± 0.04 ^{i,B}	2.00 ± 0.06 ^{j,C}
6	3.20 ± 0.08 ^{e,A}	3.10 ± 0.04 ^{h,A}	2.50 ± 0.05 ^{i,B}
9	3.80 ± 0.04^{d,A}	3.30 ± 0.05 ^{h,B}	3.00 ± 0.07 ^{h,C}
12	4.80 ± 0.04 ^{c,A}	4.50 ± 0.08 ^{g,B}	3.40 ± 0.05 ^{g,C}
15	5.50 ± 0.03^{b,A}	5.00 ± 0.05 ^{f,B}	4.00 ± 0.07 ^{f,C}
18	7.30 ± 0.04^{a,A}	6.80 ± 0.07 ^{e,B}	4.60 ± 0.06 ^{e,C}
21		7.60 ± 0.03 ^{d,A}	5.20 ± 0.04 ^{d,B}
24		9.50 ± 0.04 ^{c,A}	8.50 ± 0.06 ^{c,B}
27		12.45 ± 0.17 ^{b,A}	10.43 ± 0.15 ^{b,B}
30		14.87 ± 0.16 ^{a,A}	11.45 ± 0.15^{a,B}

Values are expressed as means ±SD (n = 3).
$^{a–j}$Means within each row with different superscripts are significantly ($p \leq 0.05$) different.
$^{A–C}$Means within each column with different superscripts are significantly ($p \leq 0.05$) different.

Total soluble solids, titratable acidity, pH and ascorbic acid

The total soluble solids (TSS) content showed a Significant ($p \leq 0.05$) increase in TSS values were observed across the storage period for control and chitosan coated samples. Also, the TSS values were found to be significantly ($p \leq 0.05$) lower for chitosan treated samples (AC & BC) when compared with control samples (CC) without chitosan treatments. The difference in the TSS values with in chitosan treated values were found to be non-significant. The increase in TSS content was delayed in the fruits treated with chitosan. It is expected to increase during ripening and decrease during storage (Tasdelen and Bayindirli, 1988).

The titratable acidity of guava fruit fell after thirty days of storage. Initially acidity for the three samples were found to be 0.45±0.02. After 18 days of storage the acidity values were recorded as 0.37±0.02, 0.38±0.02 & 0.40±0.01 for control and chitosan coated samples (AC & BC) respectively. Significant ($p \leq 0.05$) decrease in acidity values were reported for all the three samples during storage. There was no significant difference observed with control and chitosan treated samples. The same results were observed in a study by Raffo *et al*. (2002) which shows the acidity decreased with maturation and increased with high percent of sugar content in fruit.

Table 2: Titratable acidity of Chitosan Coated and Uncoated guava samples

Storage periods (Days)	Control (CC)	Chitosan-0.25%(AC)	Chitosan-0.5%(BC)
0	0.45±0.02 ^{a,A}	0.45±0.02 ^{a,A}	0.45±0.02 ^{a,A}
3	0.45±0.02 ^{a,A}	0.45±0.02 ^{a,A}	0.45±0.03 ^{a,A}
6	0.42±0.01 ^{ab,A}	0.43±0.01 ^{a,A}	0.44±0.01 ^{a,A}
9	0.40±0.01 ^{ab,B}	0.43±0.01 ^{a,A}	0.43±0.02 ^{ab,A}
12	0.38±0.03 ^{b,A}	0.42±0.03 ^{ab,A}	0.43±0.01 ^{ab,A}
15	0.37±0.02 ^{b,B}	0.41±0.02 ^{ab,A}	0.42±0.01 ^{abc,A}
18	0.37±0.02 ^{b,A}	0.38±0.02 ^{bc,A}	0.40±0.01 ^{abcd,A}
21		0.38±0.01 ^{bc,A}	0.40±0.02 ^{abcd,A}
24		0.36±0.01 ^{c,B}	0.38±0.01 ^{bcd,A}
27		0.35±0.01 ^{c,B}	0.37±0.01 ^{cd,A}
30		0.34±0.01 ^{c,B}	0.36±0.01 ^{d,A}

Values are expressed as means ±SD (n = 3).
$^{a–d}$Means within each row with different superscripts are significantly ($p \leq 0.05$) different.
$^{A–B}$Means within each column with different superscripts are significantly ($p \leq 0.05$) different.

The increase in pH shows that organic acids provide most of the hydrogen ions in guava and normally decrease with ripening produce an increase in pH. The data on changes in pH values revels that uncoated samples (CC) stored for 30 days changed slightly its pH value during storage while no significant differences were founded in both the coated samples (AC& BC). No significant ($p \leq 0.05$) changes were observed in pH values during storage and within the samples. The physico-chemical parameters like total soluble solids, titratable acidity, pH may also influenced by factors such as cultivar, cultural practices, region of cultivation and season (Suarez *et al*., 2008).

The ascorbic acid content of the whole guava fruit decreased after 30 days of storage. The guava fruit that has been treated with chitosan (0.25%) has a greater retention of ascorbic acid content. There was a significant difference in vitamin-C content between the 0.25% coated with control and 0.5% coated samples.

Table 3: Vitamin C of Chitosan coated and uncoated guava samples

Storage period (Days)	Control (CC)	Chitosan-0.25%(AC)	Chitosan-0.5%(BC)
0	225±5.44 ^{a,A}	225±5.44 ^{a,A}	225±5.44 ^{a,A}
3	221±3.50 ^{ab,A}	223±3.50 ^{ab,A}	224±2.22 ^{ab,A}
6	221±4.20 ^{ab,A}	223±4.20 ^{ab,A}	223±3.80 ^{ab,A}
9	218±2.80 ^{ab,A}	221±2.80 ^{ab,A}	220±2.30 ^{abc,A}
12	217±3.55 ^{ab,A}	220±3.55 ^{ab,A}	220±2.50 ^{abc,A}
15	215±1.58 ^{b,A}	218±1.58 ^{abc,A}	219±2.05 ^{abcd,A}
18	215±2.40 ^{b,A}	218±2.40 ^{abc,A}	219±2.80 ^{abcd,A}
21		216±3.30 ^{abcd,A}	217±3.10 ^{abcd,A}
24		214±2.90 ^{bcd,A}	215±3.50 ^{bcd,A}
27		210±3.15 ^{cd,A}	212±2.55 ^{cd,A}
30		208±1.68 ^{d,A}	210±2.32 ^{d,A}

Values are expressed as means ±SD (n = 3).
$^{a–d}$Means within each row with different superscripts are significantly ($p \leq 0.05$) different.
^{A} Means within each column with different superscripts are significantly ($p \leq 0.05$) different.

Conclusion

Considering the increasing demands of consumers, the use of safe emerging technologies and additives based on natural compounds could be an alternative in the preservation of fresh fruits. Thus the technologies are applicable to extent the shelf life of fresh whole guava. In conclusion, to increase the shelf life of the guavas, chitosan coatings can be considered for commercial application to extend the storage period of fresh produce.

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