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Effect of Gum Arabic Coatings on Physico-Chemical and Sensory Qualities of Guava (*Psidium guajava* L) cv. Shweta

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A B S T R A C T

An experiment was conducted to study the effect of gum arabic (2.5, 5 and 10%) coatings on physicochemical and sensory qualities of guava (*Psidium guajava* L cv. Shweta) during storage at ambient conditions (average day/night temperature 21.5/12.8 ºC and humidity 52%) for 9 days. The physical and biochemical observations were recorded at 3 days interval during storage. The gum arabic (GA) 10% coating significantly reduced physiological loss in weight (PLW) and retained higher firmness, ascorbic acid, peel chlorophyll content and marketable fruits as compared to control. The minimum PLW (15.41%) and the maximum ascorbic acid (181.7 mg/ 100 g pulp), peel chlorophyll (72.55±4.10 mg/g) and firmness (8.12±1.67 kg/cm^2) were observed in GA 10% coated fruits, while uncoated fruits reported to having higher PLW (19.23%) and lower ascorbic acid (126.1 mg/100g), peel chlorophyll (36.21±3.54 mg/g fresh weight) and firmness (3.33±1.08 kg/cm^2) at the end of the 9 days storage period. Maximum acceptability in terms of colour (7.66) retained by GA (10%) followed by 5% GA (7.48) coating at the end of the storage. These results suggest that application of GA 10% coating was effective for retaining physico-chemical qualities of guava and the preservation of the sensory characteristics of the fruit during storage at room temperature.

Introduction

Guava known as 'Apple of the Tropics' is an important commercial fruit crop of India. It is the fourth most important fruit crop after mango, banana and citrus. India is the world's largest producer of guava with an annual production of 4.05 million metric tons from 0.26 million hectare area (NHB, 2015). The guava is rich in vitamins such as vitamins A, B_1 (thiamine), B_2 (riboflavin) and C (ascorbic acid). The vitamin C content of guava fruit is 2-5 times higher than that of citrus fruit. The fruit is good source of pectin, fibre, calcium and phosphorus (Singh, 2005). Cultivar Shweta is the selection from half sib population of Apple Color guava variety.

Its fruits are medium size (200-225g), having snow white flesh, high TSS (12.5-13.8 ºBrix) and high vitamin C content (300 mg/100 g pulp). Good quality, high yield and wider adaptability led to fast expansion in area of cv. Shweta in Maharashtra, Andhra Pradesh, Punjab and Haryana (http://www.cish.res.in/varieties_develop.php)

Guava fruits are highly accepted by the consumers in firm, mature and green peel colour stage for fresh consumption. Fruits show peak in respiration and ethylene production after harvesting owing to its climacteric behavior (Bashir and Abu-Goukh, 2003). Under ambient conditions guava fruit become overripe and mealy within 4-5 days, whereas, in cold storage below 10 °C severe chilling injury symptoms may appear in the form of skin surface pitting and flesh browning (Wang *et al.,* 2009; Mahajan *et al.,* 2009). These drawbacks limit long distance transportation, storage and warrant immediate marketing and consumption after harvest. At present, there are no reliable methods for prolonging the shelf life and retaining the quality of guava fruit under ambient conditions.

The edible coatings have been used to extend shelf life, retain freshness and keeping quality of fruits. Coatings act as an obstruction on the fruit surface, and regulate the internal gas atmosphere, reducing moisture loss, retain peel pigments and delaying fruit ripening (Bourtoom, 2008). Gum arabic also known as acacia gum is a natural gum obtained from *Acacia* species secretion. It is a mixture of polysaccharides and glycoproteins used in industries for film forming, emulsification and encapsulation properties. Earlier, shelf life has been extended by applying gum arabic coating in tomato (Ali *et al.,* 2010), mango (Khaliq *et al.,* 2015), sweet cherry (Mahafaudi and Hamdi, 2014) and green chillies (Chitravathi *et al.,* 2014). Therefore, the aim of this study was to understand the effect of gum arabic coating on extending shelf life, retaining freshness and quality of guava fruits during storage under ambient conditions.

Materials and Methods

Fully mature, green and firm fruits of Shweta variety were procured from the experimental orchard of ICAR-Central Institute for Subtropical Horticulture, Lucknow during January, 2017. Healthy fruits (n = 360) of uniform size without any defect were washed and spread on the clean floor for air drying. The experiment involves 4 treatments, each with three replications. The 360 fruits were divided into 4 lots of 90 fruits for each treatment. The three lots of fruits were dipped in 2.5, 5 and 10% aqueous solution of gum arabic for 5 minutes, remaining one lot was dipped in water which was kept as control. Following each treatment fruits were air dried, packed in corrugated fibre board boxes (CFB) and stored under ambient conditions (average day/night temperature 21.5/12.8 ºC and humidity 52%) for 9 days. After 3, 6 and 9 days fruits (n = 30) from each treatment were sampled at random and used for physical, quality and sensory parameters analysis.

Physical analysis: Post-treatment physiological loss in weight (PLW) in both coated and control fruits were recorded at each sampling interval up to 9 days. PLW was calculated as the difference between the initial weight of fruit (on day-0) and the weight of fruits at the time of sampling, expressed in terms of percentage. Firmness in coated and uncoated fruits was measured at three points per fruit using a 'McCormick fruit tester FT 327' penetrometer with head diameter of 11 mm. Fruit firmness was expressed in kg/cm^2.

Chemical analysis: Total Soluble Solids (TSS) were measured by using hand refractometer (Erma, Japan), while titratable acidity by titrimetric methods using 0.1N NaOH (Ranganna, 2000). Peel chlorophyll was extracted in 80% acetone and estimated in spectrophotometer as method described by Pandey *et al.,* (2015) with minor modifications. Ascorbic acid in fruit pulp was estimated by titrimatric method using 2, 6-dichlorophenol indophenols dye solution and total phenol content was analyzed using Folin

and Ciocalteu phenol reagent method (Ranganna, 2000). Sensory evaluation of the fruit for taste, colour and overall acceptability for all the samples was done at 3 days interval during storage. Seven panelists were asked to score the difference between samples where 0–2 represented extreme dislike; 3–5 fair; 6–8 good; and 9 excellent for fruit colour, taste and overall acceptability. The experiment was conducted using a completely randomized design (CRD) with four replications. The data obtained were subjected to statistical analysis by using 'Statistical Software Package for Agricultural Research Workers' software at 5% significance level.

Results and Discussion

Physical parameters

The weight loss of fruits coated with gum arabic was lower than control fruits irrespective of concentration of coating solution (Fig. 1). A significant difference in weight loss was observed between the coated and control fruits. At the end of 9 days period minimum weight loss was observed in 10% gum arabic coated fruits (15.46±1.95%) followed by 5% gum arabic treated fruits (17.67±1.42%) while in control fruits (19.95±2.35%) maximum weight loss was observed. Weight loss was more pronounced during initial 3 days of storage, after that comparatively steady loss was observed in both coated and uncoated fruits.

The weight loss during storage might be due to water loss by transpiration and other physiological mechanism, the substrate loss by respiration (Juhaimi *et al.,* 2012). The slow decline in weight loss of coated fruits was due to the formation of a semi-permeable barrier against gases like oxygen, carbon dioxide, moisture and other solute movement due to which it reduces respiration, moisture loss and oxidation (Baldwin *et al.*, 1999, Ali *et al.,* 2010). The findings are in line with the results of Murmu and Mishra (2016) in 'Lalit' guava coated with sodium caseinate and tulsi extract and Ali *et al.,* (2010), who observed less weight loss in tomato fruits coated with 10% and 15% gum arabic.

Firmness significantly declined in both coated and uncoated fruits as storage period progressed (Fig. 1). At the end of the storage, maximum firmness (8.12±1.67 kg/cm^2) was observed in 10% gum arbic coated fruits followed by 5% gum arabic (7.17±1.32 kg/cm^2) coated fruits whereas minimum firmness (3.33±1.08 kg/cm^2) was estimated in control fruits. Rapid decline in firmness in control fruits was observed after 3 days of storage, whereas 5% and 10% GA treated fruits maintained significantly higher firmness until 9 days of storage. Decrease in firmness of fruits is due to pectinase and hydrolase enzyme activity that leads to degradation in cell structure, cell wall composition and inter and intracellular materials (Seymour *et al.,* 1993). Inhibition of loss of firmness by edible coatings has been reported for various fruits including 10% GA in mango (Khaliq *et al.,* 2015), 10 and 15% GA in tomato (Ali *et al.,* 2010), combined treatment of GA and chitosin in banana (Maqbool *et al.,* 2011). In this study, GA 5% and 10% coated fruits showed higher firmness than the control fruits and this may be due to thick coating which created a modified atmosphere around the fruit surface as a result reduced changes in pectin substances and activity of cell wall degrading enzymes.

Biochemical parameters

Ascorbic acid content was increased during initial three days of storage in all fruits irrespective of treatments. After three days of storage, ascorbic acid content was reduced considerably in control fruits, whereas in coated fruits it remains stable (Fig. 2a).

Fig.1 Effect of GA coatings on (a) physiological loss in weight and (b) fruit firmness during storage at room temperature

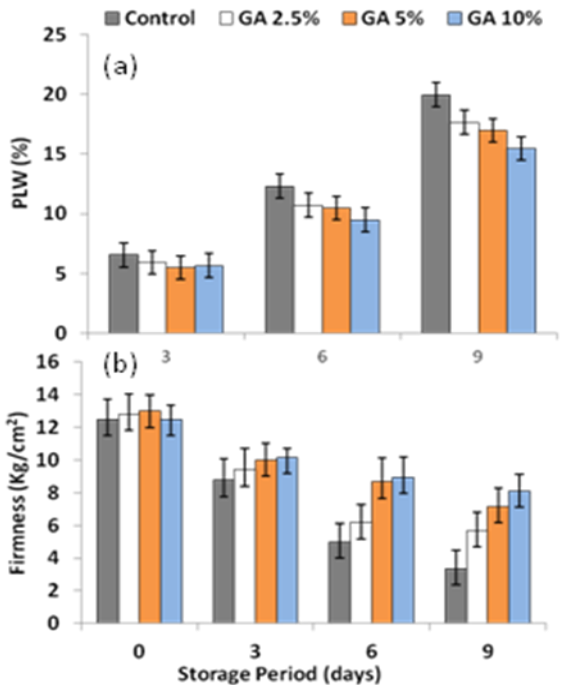

Fig.2 Effect of GA coatings on (a) ascorbic acid contents, (b) total chlorophyll contents, (c) total titrable acidity and (d) total soluble solids

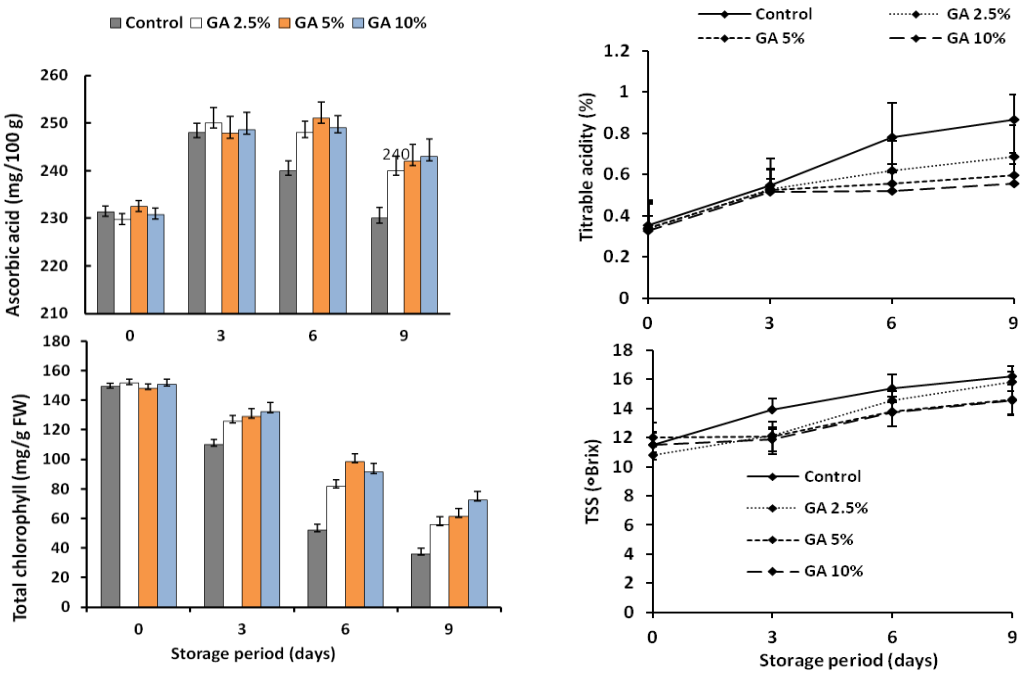

Table.1 Effect of different concentration of GA coatings on sensory score of fresh fruits stored for 9 days at room temperature

Treatments	Taste*			Colour*			Overall Acceptability*		
	3 day	6 day	9 day	3 day	6 day	9 day	3 day	6 day	9 day
Control	7.61[a]	6.8[a]	5.59[a]	8.20[a]	7.48[a]	6.77[a]	7.48[a]	6.77[a]	6.33[a]
GA 2.5 %	7.5[a]	7.30[b]	6.83[b]	8.45[a]	8.25[b]	7.13[b]	8.01[b]	7.25[b]	7.0[b]
GA 5%	8.20[a]	7.35[b]	7.33[c]	8.55[a]	8.20[b]	7.48[c]	8.56[b]	7.54[b]	7.13[b]
GA 10%	8.00[a]	7.83[c]	7.38[c]	8.53[a]	8.33[b]	7.66[d]	8.35[b]	7.88[c]	7.48[c]
CD at 5%	NS	0.28	0.32	NS	0.38	0.26	0.31	0.45	0.18

*Average of four replicates

After six days, ascorbic acid content declined in coated fruits and at the end of the storage 10% GA treated fruits retained maximum ascorbic acid (243±3.27 mg/g), whereas control fruits retained lowest ascorbic acid content (230±2.21). In guava ascorbic acid content increases with maturity and ripening, however when fruit reached full ripe stage, the ascorbic acid content starts to diminish (Tandon *et al.*, 1989). The delayed retention of ascorbic acid in coated fruits advocates that the coating slowed down the rate of ascorbic acid degradation. Similar retention of ascorbic acid content has been reported in GA coated tomato fruits (Ali *et al.*, 2010).

Chlorophyll content in guava skin is related with the consumer appeal and preference. In the present study chlorophyll content decreased as storage period progressed. In case of uncoated fruits, drastic reduction in chlorophyll content was observed after 3 days of storage and it was significantly lower than 10 % GA coated fruits (Fig. 2b). At the end of the storage period, minimum (36.21±3.54 mg/g fresh weight) total chlorophyll content was observed in uncoated fruits while maximum total chlorophyll content (72.55±4.10 mg/g) was estimated in 10% GA coated fruits. Results indicate that the coating can delay the degradation of chlorophyll. Similar results were observed by Chitravathi *et al.*, (2014) in shellac based edible coated green chilli.

Generally titratable acidity of fruits usually tends to decrease during fruit ripening. Increase in acidity has been reported in few varieties of guava (Bashir and Abu-Goukh, 2003; Mahmood *et al.*, 2012). Similar results were reported in present investigation where acidity in both coated and uncoated fruits increased as storage period progressed (Fig. 2c). On 9th day of storage, titratable acidity in uncoated fruit was 0.82%, whereas it was 0.50% in 10% GA coated fruits. The enhancement in titratable acidity in coated fruits might be suppressed due to reduction in the respiration rate during storage. The TSS was significantly higher in uncoated fruits as compared to coated fruits and reduction in TSS in coated fruit was directly proportional to the concentration of the coating (Fig. 2d).

The hike in TSS can be due to moisture loss from the fruits and conversion of organic acids into sugars (Gorny and Kader, 1998). The minimum TSS (14.56 ºBrix) at the end of the storage period was observed in fruit coated with 10% GA, whereas the maximum TSS (16.2 ºBrix) was estimated in uncoated fruits. It showed that the coatings provided a semi-permeable film around the fruit, modifying the internal atmosphere by reducing O_2 and/or elevating CO_2 and suppressing ethylene production. Reduction in respiration rates also slow down the synthesis and use of metabolites resulting in lower TSS (Ali *et al.*, 2010).

Sensory parameters

The sensory evaluation was carried out at post-harvest laboratory of institute by 7 panelists to evaluate colour, taste and overall acceptability of fruits during storage. The uncoated and 10% GA coated fruits showed significant difference in colour, taste and overall acceptability after 6th and 9th day of storage (Table 1). The 10% GA coated fruits showed significantly higher score for colour (7.66), taste (7.48) and overall acceptability (7.38) as compared to uncoated fruits on 6th and 9th day of storage. Similar results were observed by El-Anany *et al.,* (2009) when they treated 'Anna' apples with GA coating. The results suggest that GA can be used as edible coating to improve sensory quality and prolonging freshness of guava fruits during storage at room temperature.

The results of this study indicate that guava fruits coated with 10% GA showed a significant reduction in weight loss (%) and delay in change in firmness, titratable acidity, soluble solids concentration and colour during storage at room temperature as compared to uncoated control fruit. In addition, sensory evaluation showed that 10% gum arabic coating maintained the overall quality of the fruit fruit during storage.

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