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Screening of Different Polysaccharide based Edible Coatings on Fresh-Cut Guava and its Shelf-life Studies

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ABSTRACT

Various polysaccharide based edible coatings namely pectin, chitosan, alginate, carrageenan, starch and carboxymethylcellulose were evaluated for their efficacy in limiting microbial count and for retaining the physicochemical parameters over fresh-cut guava for a period of 7 days or until deterioration. Although pectin, chitosan and alginate were at par in limiting the microbial count but chitosan coated guava showed maximum microbial inhibition having 4.30 log cfu/g Total Plate Count, 2.80 log cfu/g Yeast & Mould and 2.90 log cfu/g coliform count on 9th day of storage which was within acceptable limits. Fresh-cut guava dipped for 5.3 minutes in 1% w/v concentration of chitosan were optimum as coating conditions with desirability of 91%. Microbial count over chitosan coated fresh-cut guava on 9th day of storage showed 3.44 log cfu/g Total Plate Count, 2.90 log cfu/g Yeast & Mould and 2.87 log cfu/g coliforms under acceptable limits while the uncoated sample had microbial count above acceptable limits on 6th day of storage. Taking into consideration microbial and physicochemical parameters, it was found that samples of coated fresh-cut guava were fit for consumption upto 10th day of storage.

INTRODUCTION

Fruits and vegetables have a limited postharvest shelf-life and are susceptible to physiological and biochemical deterioration. Consumers seek fresh packaged fruits and vegetables that are high in health-promoting elements and do not degrade in quality after harvesting [1]. Guava (*Psidium guajava L.*) is a tropical fruit that belongs to the Psidium genus and is commonly cultivated in tropical regions around the world. Due to its inherent nutritional content, attractive fragrance, excellent flavour, and delightful taste, the relevance of guava fruit has recently expanded. It's a rich source of vitamins, minerals, and phytochemicals. Guava is a climacteric fruit that continues to mature or ripen even after harvest, resulting in quick senescence or deterioration of the fruit due to an increase in the rate of respiration and metabolic activity within a short period of time. Exposed surface provides ideal condition which favors colonization of microbes which occurs due to the rise in moisture as well as dissolved oxygen on fruit surface (Nguyenthe and Carlin, 1994). The nutrients get exposed on cutting the fresh cut fruits which becomes ideal substrate favoring microbial growth. Due to its limited storage life after harvest, vulnerability to infections, and chilling harm during storage, it has commercialization restrictions.

Postharvest operations used for enhancing shelf-life of fruits and vegetables should be implemented. Technologies that are under use nowadays include modified atmosphere

packaging, preservatives, ozone radiation, application of films and coatings, controlled atmosphere packaging, disinfectant treatment and freezing [2]. Coatings are employed as passive and inactive barriers to preserve the quality of fruits and vegetables, and they may also reduce the negative effects of chemical and mechanical stresses. Coatings can also control moisture, oxygen, carbon dioxide, and ethylene transfer, as well as maintain aroma and flavour compounds and improve mechanical handling and structural integrity of fruits and vegetables [3]. This technique has emerged as an effective and environmentally-friendly alternative for conventional non-edible coatings [4] with ability to preserve fruits and vegetables quality, stability and safety, and to reduce the negative impact of chemicals on consumers and environment (Prasad *et al.,*2018). Other ingredients, such as plasticizers, emulsifiers, and additives for specific purposes, could be added throughout the coating production process to increase the coating's integrity, stability, and functioning [5]. Because of its edibility and excellent biocompatibility, polysaccharides gained more attention in safe coating production [6]. However, due to its hydrophilic nature, polysaccharides generally have weaknesses such as low water vapor resistance [7]. Polysaccharides have been widely used as a coating material in recent years, owing to their inexpensive cost and availability, as well as their increased solubility, stability, safety, nontoxicity, lack of allergens, lack of added taste and odour, and capacity to form clear coatings [8]. Some edible coatings based on chitosan have been studied to improve strawberry fruit shelf-life [9]. Xu et al. [10] reported that when 'Red globe' table grapes coated with either chitosan or chitosan and grapefruit seed extract treatment showed reduction in fungal rot (*Botrytis cinerea*) as compared to the control samples Therefore, the present study is designed to screen different types of edible coatings over the fresh-cut guava and to study the shelf life of coated fresh-cut guava under the optimized conditions.

MATERIAL AND METHODS

Protocol of fresh-cut fruit production technology includes initial washing with disinfectant, screening of different edible coatings and its shelf-life analysis.

Selection and cutting of guava

Healthy and equally sized guava were selected after hand-sorting followed by discarding defective fruit. After sorting, the fruit was washed with drinking water to remove dirt for further processing. After washing, calyx was removed and then guava was cut into small equal sized pieces with sterilized knife (wiped with 90 % ethanol). In order to avoid cross contamination during sample preparation, knives, cutting boards and other equipment coming in contact with guava were sanitized separately by wiping it using ethanol.

Disinfectant washing and screening of various polysaccharide-based coatings on fresh-cut guava

Fresh-cut guava was pre-treated with 100 ppm sodium hypochlorite solution by dipping fresh-cut guava for 30 minutes at 10°C respectively [11]. Six different edible coatings namely alginate, chitosan, pectin, carboxymethylcellulose, starch and carrageenan were taken for the experiment. These coatings were freshly made and fresh-cut guava slices were kept dipped in the coating solution (1-5%) for 3-15 minutes followed by air drying before packaging them in the air tight food grade containers [12]. Slices which were kept immersed in the distilled water were taken as the control samples. Control (uncoated) and coated samples were stored under refrigeration conditions at 5-7°C for 1 week or till deterioration. Various coating preparation procedure and treatment conditions are described below :-

T1-Control (washing fresh-cut guava with distilled water only)

T2-Alginate: Alginate coating solutions were prepared by mixing sodium alginate (2% w/v) powder in distilled water while heating on a hot plate for 10 minutes at 70 ° C until the mixture was clear. Thereafter, glycerol (2% v/v) was added in the solution where cooled and coated were used to coat the freshly cut fruit [13].

T3-Chitosan: The chitosan solution (1%) was prepared by mixing 1 g of chitosan in a 200 ml of beaker, then slowly adding 100 ml (1% W / V) of citric acid solution (~pH 3.5-4.0) followed by stirring upon a magnetic stirrer. Mixture is stirred until it becomes clear and thereby coating was formed [14].

T4-Pectin: Pectin coating solution was prepared by dissolving pectin (2 g/100 ml water) powder in the distilled water and heating at 70°C while stirring until the solution was clear. Glycerol (1.5 ml/100 ml) was also added as a plasticizer to

the solution of pectin for using it as a coating [15].

T5-Carboxymethylcellulose (CMC): Coating solution was prepared by mixing CMC powder in distilled water (1% w/v) followed by heating it at 85 °C for 30 min along with stirring until the solution was clear. 2.5 ml/100 mL of glycerol was added as a plasticizer [16].

T6-Starch: Aqueous suspensions of corn starch 5% (w/w) was prepared and gelatinized at 95°C for 30 min in thermostatic water bath by continuous mixing. After gelatinization, suspension was cooled at 50°C followed by addition of glycerol (plasticizer). 0.28 g glycerol (plasticizer) per gram of corn starch was added in the suspension (dry basis) [17].

T7-Carrageenan: 2% w/v of carrageenan powder was mixed in distilled water while heating it at 80 °C for 10 min and stirring it continuously using magnetic stirrer. The pH of the solution was set to 5.6 with 5% w/v anhydrous citric acid. Later glycerol (2% v/v) was added into the solution. Final volume of the solution was made 500 ml [18]. Microbial and physicochemical parameters were analysed before coating and after coating the fresh-cut guava at a regular interval of 3 days during storage period under refrigeration conditions. Coating which was capable in maintaining the fresh-cut fruits physical and biochemical parameters and limiting microbial growth over fresh-cut guava was selected for carrying out further optimization studies.

Shelf-Life Study of Coated Fresh-Cut Guava

Peeled and pretreated fresh cut guava slices coated with selected coating solution under optimized coatings coating conditions, was packed in the air tight PTE food grade containers and were stored under refrigeration (5-7°C) for 0-15 days. Physical, biochemical and microbial parameters were analysed at regular intervals of 3 days for 15 days or till the sample deteriorated.

Sensory analysis

A semi trained panel of 10 judges evaluated the sensory attribute on the basis of aroma, flavor, appearance, colour, texture and texture and taste on a 9 point hedonic scale. Scores given by 10 judges on each interval day were statistically analysed and mean values + standard deviation were obtained for all the quality parameters.

Analytical methods

Weight loss percentage: Loss of weight for fresh-cut guava for every coating was recorded during the storage period by examining changes in weight.

$$\text{Weight loss percentage} = \frac{\text{Initial Weight of sample} - \text{Final Weight of sample}}{\text{Initial Weight of sample.}} \times 100$$

Firmness: Firmness was measured by using Penetrometer device of LABCO brand. Fruit piece is held on the firm surface and the probe is pushed into the piece to a depth of 8mm, corresponding reading is marked as firmness level on the meter.

pH: pH of coated and uncoated sample was determined using bench top model pH meter (Systronics).

Total soluble solids: Total soluble solids (% TSS) of sample was determined by using Erma hand refractometer ranging from 0-32° Brix. Fruit juice samples were analysed for its TSS by observing demarcation line on scale.

Titratable acidity: It was determined as percentage acidity and calculated using the procedure of Amerine et al. [19]. Titratable acidity was calculated by titrating a known amount of water extract of fresh fruit against standardized 0.2 N NaOH with few drops of 1% phenolphthalein solution which acted as an indicator end point (pink colour) which should persist for at least 15 seconds.

$$\text{Titratable acidity \%} = \frac{\text{Volume of 0.2 N NaOH used X 0.2 X 6}}{\text{5g (weight of sample used)}} \times 100$$

Ripening index

Ripening Index (RI) was calculated as a ratio of Total Soluble Solids (TSS) and titratable acidity. Titratable Acidity was calculated by the titration of 10 mL fruit juice with 0.1 N NaOH using phenolphthalein until the solution becomes light pink (pH = 8.1) (AOAC 1990). TSS of the sample was measured using a digital refractometer.

Ascorbic acid

It was determined using titrimetric method by using 2, 6-dichlorophenol indophenol dye [20]. Dye factor (i.e. mg of ascorbic acid used per ml of dye) was calculated by using 5 ml of standard ascorbic acid solution and 5ml of 0.4% oxalic acid and was titrated against the dye solution (taken in the burette) to obtain a persistent pink colour. Crushed sample (10g) or known volume of fruit juice (10ml) was taken and volume of 100 ml was made up using 0.4% oxalic acid solution. The

solution was filtered using Whatman filter paper no. 4. 15 ml of oxalic acid (0.4%) was added to known volume of juice sample. Later, it was titrated against standardized dye (0.04%) to obtain a persistent pink end point. Dye solution and standard ascorbic acid solutions were freshly prepared before each analysis. The concentration was calculated as:

$$\text{mg of Ascorbic Acid/} = \frac{\text{Volume of the dye used} \times \text{Dye factor} \times \text{Final Volume}}{100\ (\text{g or ml})\ \text{Volume taken for titration} \times \text{Weight of sample}} \times 100$$

Total phenols

Total phenols were calculated by using method of Malik and Singh [21]. 0.5 ml of the juice extract was taken, to which 1ml each of Folin-Ciocalteu reagent (diluted 1:2 with distilled water) and sodium carbonate (35 grams of sodium carbonate mixed in 60 ml distilled water and final volume made up to 100ml) were added and mixed. It was kept for incubation for 10 mins at room temperature. Later, 2 ml of distilled water was put in each tube and color intensity was noted at 620 nm against reagent blank. The standard curve was prepared using gallic acid (10-100µg/ml) which was used for calculating total phenols.

Total sugars

Total sugars of the coated and uncoated samples were calculated using the Dubois method [22]. 1 ml of fruit juice was diluted for 100 times. 0.5 ml was taken from this dilution. 1 ml of 5% phenol reagent and 5 ml conc. sulphuric acid was added to 0.5 ml of juice extract. It was mixed using vortex followed by cooling it for few minutes. The intensity of color was noted at 490 nm against reagent blank. The standard curve was prepared using dextrose (10-100 mg/ml) which was used for calculating the concentration of total sugars.

Microbial count

The quantitative assay of the microbial count in pre and post treated samples was carried out by serial dilution technique. Total plate count agar, yeast & mould agar and EMB agar (eosin methylene blue) was used for the microbial enumeration on the fresh-cut guava pieces. 10g fresh-cut (treated and untreated) guava was suspended into 90ml of sterile water blank to make 10^{-1} dilution. Afterwards, 1ml of the aliquot was accurately pipette out into the 9 ml test tube to give 10^{-2} dilution and in the same way the sample were serially diluted to 10^{-5} dilution. 1ml of the sample was taken from 10^{-2} dilution in the petri dish and desired media was poured onto it. Microbial count was noted after 2 days of incubation period at respective incubation temperature of each media plate.

$$\text{Microbial colonies (cfu/g)} = \frac{\text{no. of colonies x dilution factor}}{\text{Weight of sample (g)}}$$

The values were later converted into log values for further reporting results and statistical analysis for critical difference values calculation.

RESULTS AND DISCUSSIONS

Disinfectant Washing and Screening of Various Polysaccharide-based Coatings on Fresh-Cut Guava

Microbial count over fresh-cut guava got reduced by 0.44 log cfu/g Total Plate Count (Total Plate Count), 0.8 log cfu/g yeast and mould (Yeast & Mould), 0.7 log cfu/g coliforms after disinfectant pre-treatment. There was no significant change observed in the physicochemical parameters namely pH, TSS, firmness, sugars, phenols, ascorbic acid, acidity and ripening index which were taken before and after pre-treatment washing of fresh-cut guava with sodium hypochlorite solution. Concentration of 100 ppm to 200 ppm NaOCl was used to decrease the microbial growth over the fresh-cut pear, apples, guava and pomegranate with calcium chlorite dipping [23]. Various edible coatings namely chitosan, pectin, alginate, carrageenan, starch and CMC were made as explained in material and methods. Fresh-cut guava was dipped in the respective coating solutions (1-5%) for 3-15 minutes according to the literature [13-18]. Slices immersed in distilled water were considered as the control samples. Results revealed that coated samples showed more microbial inhibition during storage period irrespective of the coating used. However, uncoated samples have more microbial load over fresh-cut guava since it started deteriorating after 5-6 days of storage as compared to coated samples.

In case of fresh-cut guava (Table 1) control sample and coated samples have 4.00-4.13 log cfu/g Total Plate Count (Total Plate Count), 2.60 – 2.77 log cfu/g Yeast & Mould count (Yeast and mould), 2.60 – 2.84 log cfu/g coliform count after disinfection pre-treatment at 0 day of storage. After evaluating the data, it was found that chitosan, pectin and alginate were at par in limiting microbial growth over fresh-cut guava also (Table 1). But it was found in case of fresh-cut

guava that chitosan coating showed maximum microbial inhibition during storage period and had 4.30 log cfu/g Total Plate Count, 2.80 log cfu/g Yeast & Mould and 2.90 log cfu/g coliform count at 9th day of storage period (Table 1) which was within acceptable limits. Chitosan gave significantly better results in terms of microbial inhibition over fresh-cut guava. Hence, chitosan was selected for further optimization studies over fresh-cut guava. Liu et al. [24] reported about the fungitoxic property of chitosan against grey mold and blue mold in tomato. Chitosan could strongly inhibit elongation of germ tube, spore germination and growth of mycelia in *Botrytis cinerea* and *Penicillium expansum*. The cationic properties of chitosan offer the film-maker an opportunity to take advantage of electrostatic interactions with anionic, partially demethylated pectins [25]. In addition, the antimicrobial activity of chitosan against a range of foodborne filamentous fungi, yeast, and bacteria has attracted attention as a preservative of natural origin [26].

Table 1: Microbial count of coated fresh-cut guava during storage period.

Coatings	Total Plate Count (log cfu/g)		Yeast &Mould count (log cfu/g)		Coliform count (log cfu/g)	
	Day 0	Day 9	Day 0	Day 9	Day 0	Day 9
Control	4.08	5.39	2.74	4.30	2.74	4.07
Chitosan	4.00	4.30	2.60	2.80	2.69	2.90
Pectin	4.07	4.46	2.69	2.90	2.60	2.95
Alginate	4.13	4.59	2.69	2.95	2.69	2.95
CMC	4.07	4.56	2.77	3.00	2.69	3.07
Starch	4.11	4.67	2.74	3.17	2.77	3.17
Carrageenan	4.13	4.49	2.72	3.07	2.84	3.07
CD (5%)	0.23		0.23		0.21	

Physicochemical analysis of coated and uncoated fresh-cut guava showed variable changes for with respect to physicochemical parameters studied. Results in regard with weight loss of guava fruit indicated that there was an overall increase noticed in the weight loss during its storage and this weight loss continued until the fruit reached to a completely ripened stage (Table 2). Evaporation was induced due to water vapor pressure gradient in different areas of the fresh-cut fruit can be the main reason which contributed to weight loss [26]. However, the fresh-cut guava coated with an edible coating showed a lesser reduction in the weight loss as compared to the control (uncoated) fruit [27].

Fresh-cut guava coated with chitosan, CMC and starch were firmer than the control samples. The decrease in firmness can be attributed to decrease in fruit ripening. Softening of fresh-cut guava occurred due to rapid modification of cell wall and its disassembly caused by enzymatic action, causing solubilisation and depolymerization of cell wall components namely pectin and hemicelluloses. The stability of fresh-cut fruit in terms of firmness is a crucial factor for enhancing the shelf-life of fresh-cut produce [28]. Moreover, it can also be related with the weight loss of fresh-cut papaya [29].

Table 2: Physicochemical parameters of coated and uncoated fresh-cut guava at 9th day of storage.

Coatings	pH	TSS (° Brix)	Firmness(lb)	Total sugars (g/100 g)	Phenols (mg/100 g)	Titratable acidity (%)	Ascorbic acid (mg/100 g)	Ripening index	Weight loss (%)
Control (uncoated)	4.35±0.01	11.4±0.1	4.00±0.1	3.91±0.02	337.3±5.25	0.19±0.01	95.19±0.1	58.9±3.5	0.8±0.2
Chitosan	4.32±0.01	10.83±0.11	4.10±0.1	3.90±0.04	347.0±3.93	0.20±0.01	95.16±0.15	54.2±3.2	0.7±0.3
Pectin	4.32±0.01	11.20±0.1	3.96±0.05	3.92±0.01	340.0±1.04	0.20±0.02	95.10±0.1	55.3±5.05	0.6±0.2
Alginate	4.31±0.01	11.00±0.2	3.96±0.15	3.92±0.01	339.0±1.16	0.19±0.01	95.19±0.1	56.0±3.74	0.7±0.3
CMC	4.33±0.02	10.90±0.2	4.10±0.1	3.90±0.01	339.3±2.13	0.21±0.01	95.20±0.1	52.0±3.45	0.6±0.2
Starch	4.32±0.02	10.90±0.1	4.10±0.1	3.92±0.01	342.3±1.60	0.19±0.01	95.20±0.1	55.0±4.58	0.7±0.3
Carrageenan	4.33±0.02	10.93±0.25	3.90±0.1	3.88±0.02	342.0±2	0.19±0.02	95.40±0.05	57.0±7.6	0.6±0.3
CD (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS

*NS – Non significant; * CD – Critical Difference

*All values are mean of triplicates.

In the current study, it was observed that the total soluble solid content was higher in the uncoated guava compared with the coated guava with non significant difference between the two (Table 2). The increase in the total soluble solid in the uncoated guava might be due to increased rate of degradation of polysaccharides into simple sugars. It could also be due to the moisture loss that occurred upon cutting the fruit which resulted

in the accumulation of sugars in the tissues. However, the coated sample exhibited minimal increase in the values of total soluble solid by acting as barrier to fresh-cut fruit. Edible coatings did not significantly affect TSS in fresh-cut guava (Table 2). Similar results were reported in strawberries and blueberries coated with chitosan [30], and in cherries coated with sodium caseinate [31].

Increase in pH might have occurred due to senescence and ripening of the fruits due to which there was a decrease in the acid content of the fruit because acids are considered as an important substrate for respiratory metabolism (Table 2). The greater is the metabolic respiration rate, the higher will be the decrease in the acidity of the fruit and vice versa. Hence, the change in the acid content of fruit is indicator for examining the ripening stages [32]. However, no significant change in pH was observed among the coated and uncoated (control) guava.

It was found that the Ascorbic Acid (AA) values decreased gradually in both coated and uncoated fresh-cut fruits during storage (Table 2). This might be due to the reduced access of oxygen to tissues of coated fresh-cut fruits as compared to that of the uncoated samples. Ascorbic acid degradation is known to be highly dependent upon the oxygen concentration [33]. A similar result was observed by Brasil et al.[34] on fresh-cut papaya which was coated with polysaccharide-based coating material.

Phenols were also found differ non significantly w.r.t coatings (Table 2). However, during the storage period, phenolic content was observed to decrease significantly in the coated guava. phenol content is known to be affected by certain factors such as wound stress caused during processing, which could promote enzymatic oxidation of phenols. Initial decrease in phenol content can be attributed to enzymatic browning caused due to wound stress caused during processing [35]. There was no significant difference observed in total phenols among coated fruits viz. papaya and guava with different coatings.

The total sugars content in the fruit is considered as one of the most important criteria to examine the fruit ripening stage. Sariful et al. [36] reported about a steady increase in the reducing sugar content and the total sugar content in bananas during the storage period. The amount of sugar content is the important attribute and can be preserved within the fruit even after ripening for long period by using this affordable method of coating the fruits. Total sugars had non significant difference w.r.t coating when compared with the uncoated (control) samples. Tiwary and Singh [37] reported about the paraffin coating which were able to reduce the increased rate of respiration, which ultimately led to degradation of sugar content of fruit after ripening.

A delay in the rise of Ripening Index (RI) in the coated samples was observed in Table 2. Ripening index i.e., brix/acid ratio was observed to be highest in the case of the control which was 58.9 in fresh-cut guava (Table 2). All the coated samples had values lesser than that of the control samples. Overall, ripening process in the fruits was found to be delayed with the use of coatings. Similar results were reported in the case of mandarin fruit which was coated with alginate enriched with *Fircus hirta* fruit extract.

Overall, coated samples showed minimum alteration in physical and biochemical parameters of fresh-cut guava. There was non significant difference found in physicochemical properties of fresh-cut guava w.r.t coatings over them. Results revealed that all coatings were capable to retain the physicochemical characteristics of fresh-cut guava as compared to uncoated samples. Results indicated that the fresh-cut guava dipped for 5.324 minutes in 1% w/v concentration of chitosan was optimum as coating conditions with desirability of 91% [38].

Shelf-life analysis of chitosan coated fresh-cut guava

Shelf-life analysis of fresh-cut guava was studied by treating them with sodium hypochlorite (100 ppm) and thereafter coated with chitosan under optimized coating conditions. After pre-treatment and coating under optimized conditions, the coated fresh-cut guava was packed in food grade containers and stored under refrigeration conditions. Microbial analysis of uncoated samples of guava has the count of 3.53, 2.21 and 2.34 log cfu/g on Total Plate Count, Yeast & Mould and EMB respectively on 0^{th} day of storage that increased to 5.21 log cfu/g Total Plate Count, 3.11 log cfu/g Yeast & Mould and 3.21 log cfu/g coliforms at 6^{th} day of storage (Table 4). While the chitosan coated fresh-cut guava had microbial load within acceptable limits even after 9^{th}-10^{th} day of storage 3.44 log cfu/g Total Plate Count, 2.90 log cfu/g Yeast & Mould and 2.87 log cfu/g coliforms viz. *Salmonella* spp., *Shigella* spp. and *Listeria* spp. was not found over the fresh-cut guava before and after coating. Physicochemical parameters showed non-

significant difference in values of firmness 4.3 – 4.1 (lb), TSS 10.9-11.2(◦B), pH 4.26-4.28, titratable acidity 0.16-0.18 (%), total phenols 336-340 (mg/100g) and total sugars 3.20-3.23 (g/100g) in coated fresh-cut guava (Table 3). Microbial count over chitosan coated fresh-cut guava on 9th day of storage showed 3.44 log cfu/g Total Plate Count, 2.90 log cfu/g Yeast & Mould and 2.87 log cfu/g coliforms under acceptable limits while the uncoated sample had microbial count above acceptable limits on 6th day of storage. Taking into consideration microbial and physicochemical parameters, it was found that upto 10th day samples of coated fresh-cut guava were fit for consumption. Sensory analysis of coated and uncoated sample was carried by semi trained panel of ten judges. Sensory score of both coated and uncoated fresh-cut guava at 0 day got 8 points score on the hedonic scale that showed treatment doesn't affect the sensory attributes of the sample. At 9th day of storage coated fresh-cut guava scored 7 points that was a good sensory score w.r.t physicochemical parameters from consumers point of view. Shelf-life studies shows that pre-treated chitosan fresh-cut guava can be consumed till 10th day of storage.

Table 3: Shelf-life analysis of chitosan coated fresh-cut guava under refrigeration conditions.

Parameter	coated 0 day	Storage under refrigeration at 5-7°C (days)				CD (5%)
		3	6	9	12	
TSS (°B)	10.9±0.1	11.0±0.1	11.1±0.1	11.1±0.1	11.2±0.1	0.17
pH	4.27±0.01	4.27±0.01	4.26±0.01	4.26±0.01	4.26±0.01	NS
Titratable Acidity (%)	0.18±0.01	0.17±0.01	0.17±0.01	0.16±0.01	0.16±0.01	NS
Firmness (lb)	4.3±0.1	4.2±0.1	4.2±0.1	4.1±0.1	4.1±0.1	NS
Total Phenols (mg/100g)	339.0±0.1	339.0±0.1	338.0±0.1	337.0±0.1	336.0±0.1	0.17
Total Sugars (g/100g)	3.21±0.01	3.21±0.01	3.22±0.01	3.23±0.01	3.23±0.01	NS
Ascorbic acid (mg/100g)	95.30±0.05	95.20±0.1	95.19±0.1	95.16±0.15	95.10±0.1	0.19
Ripening index	60.56±0.01	64.70±0.01	65.29±0.01	65.30±0.01	68.04±0.01	1.67
Weight loss (%)	0.3±0.1	0.3±0.1	0.4±0.1	0.4±0.1	0.5±0.1	NS
Sensory score (out of 9)	8	7	7	7	6	1.23

*CD – Critical difference; NS – Non significant

CONCLUSION

After disinfection treatment, six different coating solutions (Pectin, Chitosan, Alginate, Starch, CMC and Carrageenan) were evaluated. Amongst all the coatings, chitosan for fresh-cut guava shows the maximum log % Total Plate Count, Y & M and coliforms growth inhibition w.r.t control uncoated sample during its storage under refrigeration conditions. Although pectin, chitosan and alginate showed at par results in limiting microbial growth over fresh-cut guava yet chitosan showed more promising results to inhibit the microbial growth over fresh-cuts during storage. Hence, chitosan was selected for the fresh-cut guava for further optimization studies. Optimization of coating conditions viz. concentration of coating solution and dipping time revealed that fresh-cut guava dipped in 1% (w/v) chitosan for 5.324 minutes (unpublished data) showed minimum alteration in physicochemical parameters along with maximum inhibition of microbial growth. Shelf-life studies showed that pre-treated chitosan fresh-cut guava can be consumed till 10th day with all its desirable physicochemical properties and sensorial characteristics retained having microbial load under acceptable limits. Uncoated guava had a shelf-life of 5-6 days, after which the microbial limits exceed the acceptable limits along with deterioration in physicochemical characteristics.

Table 4: Microbiological analysis of chitosan coated and uncoated fresh-cut guava during shelf-life studies.

Parameters	Uncoated			CD (5%)	Coated					CD (5%)
	0	3rd	6th		0	3rd	6th	9th	12th	
Total Plate Count (log cfu/g)	3.53	4.74	5.21	1.23	3.0	3.3	3.39	3.44	3.5	0.34
Yeast & Mould count (log cfu/g)	2.21	2.38	3.11	0.89	1.5	1.77	2.67	2.90	3.00	1.22
Coliform count (log cfu/g)	2.34	2.61	3.21	1.09	2.0	2.20	2.39	2.87	3.32	1.05

*CD – Critical Difference

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