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Effect of edible coatings on biochemical properties and storage life of bell pepper (*Capsicum annuum* L.) under ambient condition

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Abstract: Bell pepper fruits coated with chitosan and *Aloe vera* gel, showed significant changes with respect to changes in biochemical properties over different storage durations. Fruits coated with 1 % chitosan showed best results in all biochemical properties, *viz.,* highest total acidity (0.22 %), minimum loss in ascorbic acid (84.00 mg 100^{-1}g) and decreased level of antioxidant activity (204.94 mg 100^{-1}g). Whereas, *Aloe vera* gel at 20 % showed better results with respect to least microbial (bacteria and fungi) growth at the end of 9 days of storage (0.09 X 10^3 and 0.15 X 10^3 CFU/g respectively.

Key words: Edible coating, Chitosan, *Aloe vera*, Capsicum, Biochemical properties

Introduction

Bell pepper is one of the most popular and high value commercial vegetable grown throughout the world. Nevertheless, it is a very perishable vegetable with a short shelf life and high susceptibility to fungal diseases (Hardenburg *et al.,* 1990). Bell pepper (*Capsicum annuum* L.) also known as capsicum or sweet pepper belongs to the family Solanaceae, and is believed to be the native of Tropical South America. Bell pepper occupies a pride of place among vegetables in Indian cuisine because of its delicacy and pleasant flavor coupled with rich content of ascorbic acid and other vitamins and minerals. Nutritionally, as a food, pepper has low energy value (25 kcal/100 g), but it is an excellent source of vitamin A (530 IU/100 g) and vitamin C (128 mg/100 g) and a good source of vitamin B2 (0.05 mg/100 g), potassium (195 mg/100 g), phosphorus (22 mg/100 g) and calcium (6 mg/100 g) (Bosland, 1996). Bell pepper fruits commonly encounter postharvest problems, such as rapid quality degradation at ambient condition, chilling injury when stored at temperatures below 7^0C and shriveling associated with rapid loss of weight (Maalekuu, *et al.,* 2002). Every horticultural crop has optimal temperature, humidity and modified atmospheric conditions for better storage. The basic conditions required during transportation are proper control of temperature and humidity and adequate ventilation. In addition, the produce should be immobilized by proper packaging and stacking, to avoid excessive movement or vibration. Packaging of fresh fruits and vegetables has a great significance in reducing wastage. It provides protection from physical damage during storage, transportation and marketing. However, over-use of non biodegradable plastic trays and wrapping materials, as often seen in modern supermarkets, creates an extra burden of waste disposal and damages the environment.

Recently, edible films have been developed to extend the shelf life of fruits and vegetables. Under environment friendly technology the film is closely wrapped around the fruit controlling respiration and transpiration, thus slowing down senescence. The mechanism by which coatings preserve fruits and vegetables is by producing a modified atmosphere surrounding the product. This modified atmosphere can serve several purposes, including reducing oxygen availability and increasing the fruit or vegetables internal carbon dioxide concentration (Smith *et al*., 1987). The accumulation of CO_2 and depletion of O_2 to beneficial levels by the application of modified atmospheric packaging using polyethylene is steadily becoming more important as a treatment to prolong the storage life of perishable commodities. MA packaging needs standardization to be implemented commercially because of the range of variation in produce respiration rates and the inevitable temperature changes throughout the postharvest chain. MA packaging has been shown to prolong shelf life of green capsicums (*Capsicum annuum* L.) (Meir *et al.,* 1995), but little has been published on the possibilities and limitations of MA packaging for bell peppers. Chitosan is a cationic polysaccharide obtained from partial deacetylation of chitin, the main constituent of the crustacean skeleton. Chitosan (poly-β-(1-4) *N*-acetyl-d-glucosamine) derived from the outer shell of crustaceans, has become a promising alternative treatment for storage of fruits and vegetables due to its natural character, antifungal activity, and elicitation of defense responses in plant tissue (Terry and Joyce, 2004). The chitosan coating creates a semi permeable barrier that controls gas exchange and reduces water loss, thereby maintaining tissue firmness and reducing microbial decay of harvested vegetables for extended periods (Dong, *et al.,* 2004). This polymer is non-toxic, biodegradable and biocompatible (Shapiro and Cohen, 1997).

Aloe gel is the colourless, mucilaginous gel obtained from the parenchymatous cells in the fresh leaves of *Aloe* spp. Currently, there is an increasing interest in the use of *A. vera* gel in the food industry as a resource of functional foods in drinks, beverages and ice creams (Grindlay and Reynolds, 1986). *A. vera* gel based edible coating has been shown to prevent loss of moisture and firmness, control respiratory rate and maturation development. *Aloe vera* delay oxidative browning, and reduce microorganism proliferation in fruit and vegetables, besides its role as barrier to prevent water loss and delay of fruit senescence. Hence, this experiment was undertaken to study the effect of chitosan and *Aloe vera* gel coating on quality parameters and storage life of bell pepper with the following objectives; a)To study the effect of chitosan and *Aloe vera* gel on the biochemical proerties of bell pepper; b) To study the effect of chitosan and *Aloe vera* gel on storage life of bell pepper.

Material and Methods

The experiment was carried out at the Department of Postharvest Technology, College of Horticulture, University of Horticultural Sciences, Bagalkot, Gandhi Krishi Vignana Kendra, Bengaluru. Optimum matured, disease free, green bell pepper fruits of Indra cultivar were used for carrying out the experiment. The experiment consisted of nine treatments with three replications and was laid out on completely randomized design (CRD). The treatments *i.e.*, edible coatings were, T_1: Control , T_2: 1% chitosan, T_3: 2% chitosan, T_4: 10% *Aloe vera* gel, T_5: 20% *Aloe vera* gel, T_6:1% chitosan + 10% *Aloe vera* gel, T_7:2% chitosan + 20% *Aloe vera* gel, T_8: 1% chitosan + 20% *Aloe vera* gel, T_9: 2% chitosan + 10% *Aloe vera* gel.

The commercially available, water soluble chitosan powder was procured and used in the experiment. 10 gm of chitosan was dissolved in 1000ml of distilled water to obtain 1 per cent. 20 g chitosan was dissolved in 1000ml of distilled water to obtain 2 per cent chitosan solution. Fresh *Aloe vera* leaves were washed to remove dust, cut with knife and scooped to extract clean gel. The fresh gel was mixed thoroughly and strained through muslin cloth to remove thick particles. *Aloe vera* gel matrix was separated from the outer cortex of leaves and this colourless hydro-parenchyma was put in a blender. The resulting mixture was filtered to remove the fibers. The liquid obtained constituted fresh *Aloe vera* gel. The gel matrix was pasteurized at 50^0C for few minutes. Bell pepper fruits were selected washed in cold water and was allowed to drain the water. After the fruits were properly air dried, they were dipped in chitosan solution and *Aloe vera* gel of 10 and 20 per cent for 2 to 3 minutes and then air dried.

Bell pepper fruits were analysed for total acidity (%), ascorbic acid (mg/100g), total antioxidant capacity (mg/100g) and total micro biological count (CFU/g). Acidity of the fruit pulp was determined by titrating it with 0.1N sodium hydroxide as suggested by Ranganna (1986). Five gram of bell pepper pulp was taken and made up to 50 ml and one drop of phenolphthalein indicator was added. The flask was shaken well, uniformly mixed and the solution and titrated against 0.1N NaOH. Appearance of pink colour was considered as the end point of titration. The titratable acidity was expressed in terms of percentage anhydrous malic acid present per 100 ml of sample. Then, the acidity was calculated as:

$$\text{Total Acidity (\%)} = \frac{\text{Titre value x 0.1N NaOH x Vol. made up x Eq. wt of citric acid}}{\text{Volume of sample x Weight of sample x 1000}} \text{x100}$$

Ascorbic acid content of bell pepper samples was determined by 2, 6- dichlorophenol indophenol titration method as described by Ranganna (1986).

$$\text{Vitamin C (mg/100g)} = \frac{\text{Titre value x Dye factor x Volume made up}}{\text{Volume taken x Weight of the sample}} \text{x100}$$

The total antioxidant activity was measured by the principle; the disappearance of the DPPH radical absorption at 517nm by the action of antioxidants is measured spectrophotometrically in a methanolic solution until the absorbance remains constant. The number of bacteria or fungi (CFU) per milli litre or gram of sample was calculated by dividing the number of colonies by the dilution factor multiplied by the amount of specimen added to liquefied agar.

$$\frac{\text{Number of colonies (CFUs)}}{\text{Dilution X amount plated}} = \text{bacteria or fungi per gram.}$$

Results and Discussion

There was no significant difference between the coated and uncoated bell pepper up to 3rd day, (Table 1). The acidity of uncoated fruits as recorded on 6th and 9th day of storage was lower (0.19 % and 0.14 %) as compared to coated fruits, while the fruits coated with 1 per cent chitosan showed higher acid content (0.26 % and 0.22 %) on 6 and 9th days of storage respectively. This treatment was followed by bell pepper fruits coated with 2 per cent chitosan (0.25 % and 0.21 %) on 6th and 9th day of storage respectively. Ascorbic acid content of the fruits decreased during the storage period and was statistically significant among different treatment (Table 1). Ascorbic acid content of uncoated (control) fruits was found to decrease rapidly within 9 days of storage. It was lowest (107.87 mg/100g, 89.60 mg/100g and 74.73 mg/100g) as compared to coated fruits as recorded on 3rd, 6th and 9th day of storage respectively. The fruits coated with 1 per cent chitosan had highest ascorbic acid content (113.60 mg/100g, 99.20 mg/100g and 84.33 mg/100g) as recorded on 3rd, 6th and 9th days of storage respectively. This was closely followed by fruits coated with (T_3) 2 per cent chitosan (112.80 mg/100g, 97.60 mg/100g and 80.67

Table-1: Effect of chitosan and *Aloe vera* gel coating on total acidity (%) and ascorbic acid (mg/100g) of bell pepper fruits stored at ambient condition

Treat-ments	Total Acidity (%) 3 days	6 days	9 days	Ascorbic acid(mg/100g) 3 days	6 days	9 days
T1	0.24	0.19	0.14	107.87	89.60	74.73
T2	0.28	0.26	0.22	113.60	99.20	84.33
T3	0.26	0.25	0.21	112.80	97.60	80.67
T4	0.26	0.22	0.19	110.40	94.40	78.00
T5	0.27	0.24	0.20	112.40	96.00	79.47
T6	0.26	0.23	0.18	110.13	92.07	78.47
T7	0.26	0.22	0.16	109.60	91.93	78.40
T8	0.25	0.21	0.16	109.33	91.20	77.60
T9	0.25	0.20	0.15	108.67	90.40	76.67
S.Em±	0.01	0.01	0.01	0.89	0.71	1.19
CD@1%	-	0.04	0.04	3.60	2.87	4.84

Table-2: Effect of chitosan and *Aloe vera* gel coating on total antioxidant activity (TAA) and microbial studies (colony forming units) of bell pepper fruits stored at ambient condition

Treat-ments	TAA (mg/100g) 3 days	6 days	9 days	CFU/g Bacteria	CFU/g Fungi
T1	144.94	179.06	263.45	1.19×10^3	1.2×10^3
T2	126.71	156.71	204.94	0.28×10^3	0.39×10^3
T3	129.65	158.47	217.88	0.47×10^3	0.53×10^3
T4	135.53	164.94	243.18	0.11×10^3	0.18×10^3
T5	130.82	162.00	234.35	0.09×10^3	0.15×10^3
T6	133.18	163.76	238.00	0.29×10^3	0.66×10^3
T7	137.88	167.29	247.45	0.58×10^3	0.7×10^3
T8	140.24	172.59	254.94	0.6×10^3	0.8×10^3
T9	141.16	175.75	257.29	0.83×10^3	0.9×10^3
S.Em±	0.11	0.12	0.13	2.22	3.33
CD@1%	0.45	0.51	0.53	9.05	13.57

mg/100g) on 3rd, 6th and 9th days of storage respectively. Total antioxidant activity (fresh weight basis) of bell pepper fruits increased during the storage period and was statistically significant among different treatment (Table 2) Total antioxidant activity of uncoated (control) fruits was found to increase rapidly within 9 days of storage. It was highest (144.94 mg/100g, 179.06 mg/100g and 263.45 mg/100g) as compared to any coated fruits as recorded on 3rd, 6th and 9th days of storage respectively. The fruits coated with 1 per cent chitosan had lowest antioxidant content (126.71 mg/100g, 156.71 mg/100g and 204.94 mg/100g) as recorded on 3rd, 6th and 9th days of storage respectively. This was followed by 2 per cent chitosan (129.65 mg/100g, 158.47 mg/100g, and 217.88 mg/100g) on 3rd, 6th and 9th days of storage respectively. The microbial (bacteria) population in bell pepper fruits as influenced by different concentrations of chitosan and *Aloe vera* gel showed variation in population during the storage period (Table 3). The uncoated (control) fruits had maximum CFU/g (1.19 X 10^3) as recorded on the end of the storage (9th day), whereas, the fruits coated with 20 per cent *Aloe vera* gel showed minimum CFU/g (0.09 X 10^3). This treatment was followed by fruits coated with 10 per cent *Aloe vera* gel 0.11 X 10^3 CFU/g on 9th day of storage. The microbial (fungi) population in bell pepper fruits as influenced by different concentrations of chitosan and *Aloe vera* gel showed differences in population during the storage period (Table 3). The uncoated (control) fruits had maximum CFU/g (1.2 X 10^3) as recorded at the end of the storage day (9th day), whereas, the fruits coated with 20 percent *Aloe vera* gel showed minimum CFU/g (0.15 X10^3). This treatment was followed by fruits coated with 10 per cent *Aloe vera* gel 0.18 X 10^3 CFU/g on 9th day of storage.

Bell pepper fruits coated with different concentrations of chitosan and *Aloe vera* gel showed significant influence on titratable acidity. The fruits coated with 1 per cent chitosan had highest acid content in each day of storage. One per cent chitosan showed highest titratable acidity content of 0.22 % on the 9th day of storage. This was mainly due to delayed ripening process caused by modified atmosphere of coated bell pepper fruits. It may be due to the ability of chitosan coating to modify internal atmosphere conditions, which caused reduced respiration and transpiration rate of coated fruits, which could have slowly decreased the acid content. It was also reported that acidity decreases with ripening and senescence. Similar results have been reported in tomato (Padmini, 2006), bell pepper (Jennifer, 1997) and cucumber (Irtwange, 2006). The ascorbic acid content of bell pepper fruits had decreased with increasing ripening process. There were significant changes in ascorbic acid content of bell pepper fruits, as influenced by edible coating with chitosan and *Aloe vera* gel. The untreated bell pepper fruits lost maximum amount of ascorbic acid content during storage, while the bell pepper fruits coated with 1 per cent chitosan had lost minimum amount of ascorbic acid (84.00 mg/100g) at 9th day of storage. This was mainly due to delayed ripening process because of modification of atmosphere or coated bell pepper fruits. It may also be due to the ability of chitosan coating to modify internal atmosphere conditions, which might have reduced respiration and transpiration rate of coated fruit, to impart slow decrease in the acid content. The purpose of the two selected coatings was to help preserve vitamin content and prevent oxidation. Exposure of vegetables to high temperatures and low humidity levels had deleterious effects on their nutritional quality. Vitamin C content had decreased with storage period. In addition, pre treatments were found effective on preventing vitamin C degradation during storage period. MAP prevented vitamin C degradations caused by low O_2 concentrations. Similar results have been reported in bell pepper (Mustafa and Kenan, 2010), strawberries (Singh *et al*., 2011), chilli (Muhamad *et al*., 2012), bell pepper (Jennifer Ann Ball, 1997) and broccoli (María *et al*., 2011).

This experiment concludes that the bell pepper fruits treated with 1 per cent chitosan showed better results with respect to total acidity, ascorbic acid and total antioxidant activity, whereas, bell pepper fruits coated with 20 percent *Aloe vera* gel showed minimum microbial growth followed by fruits coated with 10 per cent *Aloe vera* gel on 9th day of storage.

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