



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

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Abstract: Chitosan and *Aloe vera* gel coatings on bell pepper creates a semi permeable barrier that controls gases exchange and reduce water loss, there by maintain tissue firmness, reducing microbial decay and delays oxidative browning. In this experiment, the bell pepper fruits coated with 1 % chitosan recorded minimum weight loss (17.56 %), maximum firmness (3.67 kg/cm²), least TSS (5.27 °B), and retained the maximum green colour at 9 days of storage. Whereas, the bell pepper fruits which were not coated with any of the edible coatings recorded the maximum weight loss (21.68 %), least firmness (2.01 kg/cm²), highest TSS (7.03 °B), and retained minimum green colour.

Key words: Edible coating, Chitosan, *Aloe vera*, *Capsicum*, Storage life

Introduction

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 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 occupies a pride of place among vegetables in Indian cuisine because of its delicacy and pleasant flavour 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°C 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 CO₂ and depletion of O₂ 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 objectives, a) To study the effect of chitosan and *Aloe vera* gel on quality parameters 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, T₁: Control, T₂: 1% chitosan, T₃: 2% chitosan, T₄: 10% *Aloe vera* gel, T₅: 20% *Aloe vera* gel, T₆: 1% chitosan + 10% *Aloe vera* gel, T₇: 2% chitosan + 20% *Aloe vera* gel, T₈: 1% chitosan + 20% *Aloe vera* gel, T₉: 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°C 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.

The Cumulative physiological loss in weight (CPLW %) of individual fruits were numbered in each treatment to record the physiological loss in weight. The weight of the individual fruit was recorded using electronic balance before storage. Thereafter, the

weights were recorded regularly during storage and the cumulative PLW was calculated using the following formulae:

$$\text{CPLW (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

The firmness of the fruit at equatorial region was measured as, the force required for puncturing the fruits using a hand penetrometer. The firmness was expressed as kg/cm². A scale of 1-5 was used for recording the colour of evenly matured green fruits by visual observations. The scores were first developed and the intermediate scales were specified as under (Vasant, 2010). Score card for surface colour of bell pepper;

Score	Description
1	Red
2	Pink
3	Light green
4	Green
5	Dark green

The TSS of bell pepper fruit juice was determined with the help of digital hand refractometer and expressed as degree Brix (°B). The readings are corrected and adjusted to ambient temperature. Care was taken that the prism of the refractometer was washed with distilled water and wiped dry before every use. All of the parameters were recorded at 3, 6 and 9 days of storage.

Results and Discussion

The experiment revealed that, the cumulative physiological loss in weight (CPLW %) of bell pepper fruits decreased during the storage period. The uncoated (control) fruits lost maximum weight (5.03 %, 11.04 %, and 21.68 % as recorded on 3rd, 6th and 9th day respectively) whereas, the bell pepper coated with chitosan 1 per cent (T₂), showed minimum loss in weight as recorded at different days of storage (3.75 %, 9.57 %, and 17.56 %) (Table-1). The fruit firmness showed similar results, wherein, the uncoated (control) fruits were softer (3.57, 2.93, and 2.01 Kg/cm² as recorded on 3rd, 6th and 9th day of storage respectively), than the fruits coated with chitosan and *Aloe vera* gel. The fruits coated with 1 per cent chitosan were found to be most firm (4.14, 4.01, and 3.67 Kg/cm²) amongst all the treatments, followed by fruits coated with 2 per cent chitosan (4.03, 3.67, and 3.28 Kg/cm² on 3rd, 6th and 9th day of storage respectively) (Table-2).

There was no significant difference among different treatment with respect to the colour of bell pepper fruits until 3rd day. The untreated (control) fruits had less green colour (3.70 and 2.03 on 6th and 9th day of storage respectively), while fruits coated with different concentration of chitosan and *Aloe vera* gel had better surface colour. The fruits coated with 1 per cent chitosan (T₂) were found to be green and slight attractive (4.40 and 3.67) amongst all the treated fruits, which was on par with T₃ (4.23) and T₅ (4.10) at 6th day of storage. Data recorded on day 9 showed T₃ (3.50) to be on par with T₂ (3.67). This was followed by fruits coated with 20 per cent *Aloe vera* gel (T₅). There were no significant differences in TSS of different treatments imposed on bell pepper fruits until 3rd day. It was found that the total soluble solids increased rapidly during the storage period. The highest being in untreated (control) fruits (4.87 °B, 5.13 °B, and 7.03 °B, as recorded on 3rd, 6th and

Table-1: Effect of chitosan and *Aloe vera* gel coating on cumulative physiological loss in weight (CPLW %) and firmness (Kg/cm²) of bell pepper fruits stored at ambient condition

Treat-ments	CPLM%			Firmness (Kg/cm ²)		
	3 days	6 days	9 days	3 days	6 days	9 days
T1	5.03	11.04	21.68	3.57	2.93	2.01
T2	3.75	9.57	17.56	4.14	4.01	3.67
T3	4.31	10.09	18.70	4.03	3.67	3.28
T4	4.55	10.24	19.78	3.72	3.57	3.10
T5	4.34	10.16	18.77	3.93	3.60	3.23
T6	4.59	10.22	19.58	3.88	3.55	3.14
T7	4.69	10.30	19.78	3.80	3.50	3.07
T8	4.68	10.35	19.68	3.68	3.46	2.72
T9	4.78	10.51	20.09	3.62	3.17	2.16
S.Em±	0.18	0.10	0.37	0.08	0.12	0.12
CD@1%	0.72	0.40	1.52	0.33	0.48	0.48

Initial CPLW- 0.00; Initial firmness- 4.70 (Kg/cm²)

9th day of storage respectively). On the other hand, TSS content of fruits coated with 1 per cent chitosan (T₂) was found to be least (4.17 °B, 4.17 °B, and 5.27 °B) amongst all the treated fruits (Table-2).

The physiological weight loss of bell pepper fruits were observed to increase with the ripening process. There were significant differences among the treatments as affected by the coating of different concentration of chitosan and *Aloe vera* gel. Wide fluctuations in temperature at ambient conditions increased the rates of water loss from bell pepper possibly by increasing vapour pressure deficit between the tissue and the surrounding air leading to enhancement of transpiration (Ben-Yoshua et al., 1987). High temperatures would have increased the rates of respiration and other metabolic processes that caused depletion of substrates like sugars and proteins resulting into further weight loss. As water evaporates from the tissue, turgor pressure decreases and the cells begin to shrink and collapse thus leading to loss of freshness. High weight loss also translates into loss of marketable weight. Lowest weight loss was observed in chitosan treatments, due to the confinement of moisture around the produce by chitosan coating. This increases the relative humidity and reduces vapour pressure deficit and transpiration. In addition, the impermeability of chitosan to gases exchange slows down the metabolic processes and transpiration. Similar results have been reported in bell pepper (Nyanjage et al., 2005), grapes (Juan et al., 2005), sweet cherry (Martinez et al., 2006) and tomato (Padmini, 2006).

The firmness of bell pepper fruits had significantly decreased and significant differences were found among the treatments. The uncoated (control) fruits lost their firmness rapidly, than the fruits coated with chitosan and *Aloe vera* gel. The fruits coated with 1 per cent chitosan were found to be most firm amongst all the treatments, followed by fruits coated with 2 per cent chitosan. This is mainly due to the retardation of ripening process. It could be attributed to the ability of selected coating (chitosan) to modify the respiration, transpiration and reduction in ethylene production rate that maintains the turgidity of tissues. On the other hand, it may be also reasoned that, chitosan coating around the bell pepper fruits, would have resulted in decreased metabolic activities and delayed ripening

Table-2: Effect of chitosan and *Aloe vera* gel coating on colour (score) and TSS (°B) of bell pepper fruits stored at ambient condition

Treat-ments	Colour (score)			TSS (° B)		
	3 days	6 days	9 days	3 days	6 days	9 days
T1	4.66	3.70	2.03	4.87	5.13	7.03
T2	5.00	4.40	3.67	4.17	4.17	5.27
T3	5.00	4.23	3.50	4.43	4.23	5.70
T4	4.91	3.90	3.20	4.57	4.77	6.43
T5	4.98	4.10	3.27	4.47	4.50	5.87
T6	4.96	3.92	3.18	4.50	4.60	6.07
T7	4.79	3.90	2.50	4.70	4.80	6.10
T8	4.82	3.87	3.12	4.73	4.97	6.30
T9	4.77	3.83	2.70	4.77	5.03	6.63
S.Em±	0.09	0.08	0.05	0.08	0.09	0.20
CD@1%	-	0.31	0.21	-	0.37	0.81

Initial colour score= 5.00

process. Similar results have been reported in bell pepper (Mustafa and Kenan, 2010) and banana (Balasooriya et al., 2006).

The fruits coated with 1 per cent chitosan (T₂) were found to be green and slight attractive amongst all the treated fruits. This may be due to the reason that, coating of chitosan and could have delayed the degradation of chlorophyll and reduced the softening of bell pepper fruits by maintaining high humidity in the vicinity of the fruits. It may also be due to reduced rate of respiration and decreased metabolic activities. Higher loss in green colour at ambient temperatures may be caused by increased breakdown of chlorophyll and synthesis of β-carotene and lycopene pigments, which occur during ripening. Similar results have been reported in bell pepper (Nyanjage et al., 2005) and nectarine (Muhammad et al., 2009). Total soluble solids content of bell pepper fruits was found to be increased considerably during storage in all treatments. Increase in TSS content of fruits might be attributed to increase in soluble solids, soluble pectin, soluble organic acids etc. The effect of chitosan in reducing the TSS of fruit was probably due to the slowing down of respiration and metabolic activity, hence retarding the ripening process. It was well documented that the filmogenic property of chitosan results into an excellent semi-permeable film around the fruit, modifying the internal atmosphere by reducing O₂ and elevating CO₂, and suppressing ethylene evolution. Similar results have been reported in bell pepper (Mustafa and Kenan, 2010), bell pepper (Gholamipour et al., 2010) and papaya (Asgar et al., 2011).

The overall conclusion of this experiment is that, bell pepper fruits coated with chitosan (1 %) recorded the least decrease in cumulative physiological loss in weight, firmness, colour and least increase in TSS. Thereby, helped in maintaining the quality of the fruits up to duration of 9 days.

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