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Effect of guar gum and alginate coatings on postharvest shelf life of ivy gourd (*Coccinia grandis* L. Voigt)

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Abstract

Attempts to prolong the shelf life of ivy gourd, a medicinally important member of the cucurbitaceae family have been made through use of edible coating. Guar gum and alginate coating was applied at commercial maturity stage. The physiological, textural and sensory parameters for the vegetables under storage at room temperature conditions (22 ± 2ºC and 90-95% relative humidity (RH) were monitored. Edible coating technique was found effective in retarding the physiological maturation and senescence. Guar gum coating was found more effective in reducing PLW (27.5%) and textural firmness (31.7%). Acidity of coated ivygourd was found to increase with maturity, however coated ivy gourd retained its fresh like colouration and flavor even after 9 days of storage at ambient temperatures

Key words: Ivy gourd, Coating, Texture, Sensory evaluation

Ivy gourd (*Coccinia grandis* L. Voigt or *C. indica* Wight) commonly known as Scarlet-fruited gourd, baby watermelon and little gourd is a tropical vegetable crop extensively used as vegetable and grows wildly throughout the Indian sub-continent. It is commonly known as 'Kundru' in India. It is natively found in India, Asia and Central Africa. The vegetable is low-priced and extensively available all year round, particularly throughout rainy season. The fruit of this plant is ovoid in shape berry type which changes green to red color when become ripe (Tripathi, 2001; Umamaheswari, 2008). The tender green fruits are nutritious and are good source of protein, calcium, fiber and beta carotene, vitamins (Suresh-Babu and Rajan, 2001). The therapeutic property of ivygourd suited to diabetes management is brought mainly by its anti-hyperglycemic, β-cell regenerative, anti-hyperlipidemic and antioxidant properties (Attanayake *et al.*, 2016). Harvesting maturity of ivy gourd is determined by the size and fruit color which changes from green to light green. The normal storage life is 3 to 4 days under ambient conditions and 7 to 10 days under refrigerated temperature conditions respectively. The ivy gourd gradually transforms towards reddish hue due to initiation of ripening and loses weight due to rapid shriveling during storage (Kulkarni, 2012). Shriveling of vegetables leads to toughening of exterior pericarp accompanied with loss in tenderness. The quality of ivy gourd can be maintained by using suitable postharvest techniques addressing these issues.

Considering the ease of application, economic viability, use of edible coatings appears to be a more promising and potential approach in reducing postharvest deterioration and

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preserving the quality of vegetables. An edible film is a thin layer of material which can be be applied on the vegetable by wrapping, dipping, brushing or spraying and is safe for consumption (Wu, 2002). It acts as partial barrier to gases and moisture exchange, aroma compounds, thereby decreasing the respiration rate and water loss of the produce and hence preserves the texture and flavor leading to enhanced shelf life (Olivas and Barbosa-Canovas, 2005). In addition, edible coatings are safe to eat and also may be made to carry certain functional ingredients such as antimicrobials, antioxidants, nutrients, and flavours to enhance food stability, quality, functionality and safety (Debeaufort, 1998; Min and Krochta, 2005). Several edible coatings have been used for extending shelf life of vegetables *viz.* gaur gum, sodium alginate, vegetable wax, shellac, chitosan etc (Chiabrando and Giacalone, 2013). Guar gum is a polysaccharide sourced from cluster bean *(Cyamopsis tetragonoloba)* which has thickening and stabilizing properties useful in various industries, including food industry, besides its growing use in the hydraulic fracturing industry. The backbone is a linear chain of β 1,4-linked mannose residues to which galactose residues are 1,6-linked at every second mannose, forming short side-branches.

Alginate is a salt of alginic acid, which is refined from brown seaweed. The chemical constituents of sodium alginate consists of D-mannuronic and L-guluronic acid (*Olivas* and *Barbosa-Canovas*, 2008). It is a cold gelling agent requiring calcium lactate or chloride to form resilient gels (Dhall, 2013). It has wide application in many areas due to nontoxicity, biocompatibility, biodegradability, and reproducibility. Both guar gum and alginate are widely accepted as GRAS ingredient in foods being sourced from vegetarian origin. They act as a thickener, emulsifier and hydration agent and preparing the edible coating films (Yang *et al.*, 2009). Edible coating based on these gums has been found useful in prolonging shelf life of cucumber is reported by Saha *et al.* (2016). Considering lack of scientific data on postharvest quality retention of ivy gourds, the study was devised with an objective of investigating the maturity related changes in quality of ivy gourd and its shelf life extension using edible coatings.

Materials and Methods

Plant Material

Fresh ivy Gourd *(Coccinia grand)* fruits are harvested were obtained during the year 2017 from ICAR-IARI, Research field, New Delhi at leaf green and attainment of potential length by the fruit which is considered as commercial mature stage for harvesting. Fruits of uniform size, color, freedom from blemishes, and insect infestation were selected for the study. Before treatment (within an hour of harvest), fruits were washed with clean water for 3 minutes and air-dried at ambient temperature (22 ± 2°C). Food Grade Gaur gum, sodium alginate, calcium chloride, glycerol, sodium hydroxide, phenolphthalein were procured from Molychem, Mumbai, India and Qualichem fine chemicals, New Delhi.

Preparation of Coating Materials

To prepare edible coating solutions, 1.5% guar gum and 0.3% glycerol was mixed with 100 ml of distilled water (Ruelas-Chacon *et al.* 2017). The solution was stirred on magnetic stirrer cum hot plate at 800 rpm at 40°C for 30 minutes. Similarly the alginate coating solution was prepared by dissolving the 2% in distilled hot water at 70°C and stirring until homogenous solution was obtained. A 2% (w/w) solution of calcium chloride was prepared to induce instantaneous cross linking reaction by dipping the fruit coated by sodium alginate.

Coating of Ivy Gourd Fruits

The washed and air dried fruits were weighed on digital balance before coating. For textural analysis and total acidity measurement the fruits were separately coated because of their destructive means of analysis. The fruits were divided into three lots: control which were dipped in distilled water, while sodium alginate and guar gum coated fruits were used as treated lots. For coating treatment, the fruits were dipped in coating solution for 3 min followed by air drying for 30 min under room conditions. For alginate coating, fruits were first dipped in sodium alginate (2%) solution for 3 minutes followed by dipping in $CaCl_2$ (2%) and glycerol (1%) solution for 1 min to form continuous film like cross-linked structure. The air dried fruits were kept in open trays at ambient condition (22 ± 2°C) for 9 days.

Physiological loss in weight (PLW)

The moisture loss due to transpiration was determined periodically by weighing the samples with a high precision electronic balance (Mettler-Toledo) before storage. Thereafter, the fruit weight was recorded regularly during storage and the cumulative physiological loss in weight (PLW) was calculated using the following (Eq. 1) :

$$\text{PLW (\%)} = \frac{(\text{Initial weight} - \text{Weight on } n^{th} \text{ day})}{\text{Initial weight}} \times 100 \quad \text{(Eq. 1)}$$

Determination of Titratable Acidity

Homogeneous crushed fruit sample (5 g) added with 45 ml of water was used for determination of titratable acidity. Titratable acidity in terms of citric acid was determined by titration against 0.1 N NaOH using phenol-phthalein indicator until stable pale pink colouration (Eq. 2). All observations were recorded in triplicates

$$\text{Titrable Acidity (\%)} = \frac{\text{Titre} \times \text{Normality of NaOH} \times 0.064}{\text{Weight of sample}} \quad \text{(Eq.2)}$$

Determination of Fruit Firmness and Toughness

The firmness of ivy gourd was measured as the indicator of textural property *i.e.*, force required for puncturing the fruit using a texture analyser (TA-XT plus, Stable Micro systems, UK). A 2 mm diameter stainless steel probe was used to conduct the probing test by using a 5 kg load cell, with test speed: 1.5 mm / sec and penetration distance of 20 mm. The firmness was defined in terms of maximum force (kgf) during the compression, which was expressed in Newtons (N). The peak in the texture curve was taken as firmness of pod (N). Internal flesh toughness (N.s) was determined by computing the area between the first peak and second peak. All experiment were conducted in triplicates.

Sensory evaluation

Sensory evaluation of treatments was conducted during the storage period regularly. The treated and control samples were given to sensory panel for analyzing. The panelists were asked to rank the sample for its appearance, and were asked to select the most and least acceptable samples based on overall evaluation. The intent to purchase was assessed on a nine-point structured hedonic scale that ranged from one (certainly would not buy) to nine (certainly would buy) (Santos *et al.*, 2012).

Statistical design and Analysis of data

The experiments were designed in a completely randomized design (CRD) with all experiments consisting of 3 replications. The data was analyzed as per the design and the results were analyzed through one way ANOVA by using SPSS version 17.0. Mean comparison of the results were done by Tukey's test with 5% level of significance.

Results and Discussions

Physiological loss in weight

Desiccation is the major contributor towards loss in visual appeal and turgidity of vegetables. Under ambient conditions, PLW of 16% was noted over a period of nine days of storage. Fig. 1 indicates the observed increase in PLW across the treatments during storage period. Weight loss in fresh produce is mainly because of the loss of water caused by transpiration and respiration (Zhu *et al.* 2008). The PLW was found to be significantly different amongst each treatment ($p < 0.05$). As expected, PLW of coated fruits was significantly lower than that of uncoated fruits (Control fruits). During the ambient storage, control fruits showed greater physiological loss in weight at an average rate of 7.78% per day, while the rate of physiological loss in weight Guar gum (GG) coated fruits was 5.57% per day. The corresponding value for alginate coated fruits was 7.39% per day. In other terms, the rate of increase in PLW for control fruits was 1.827 ($R^2 = 0.9736$), while the alginate (SA) coated fruits' PLW increase rate was 1.787 ($R^2 = 0.9736$). The minimum and slowest rate of increase in PLW was noted for GG coated fruits with k value

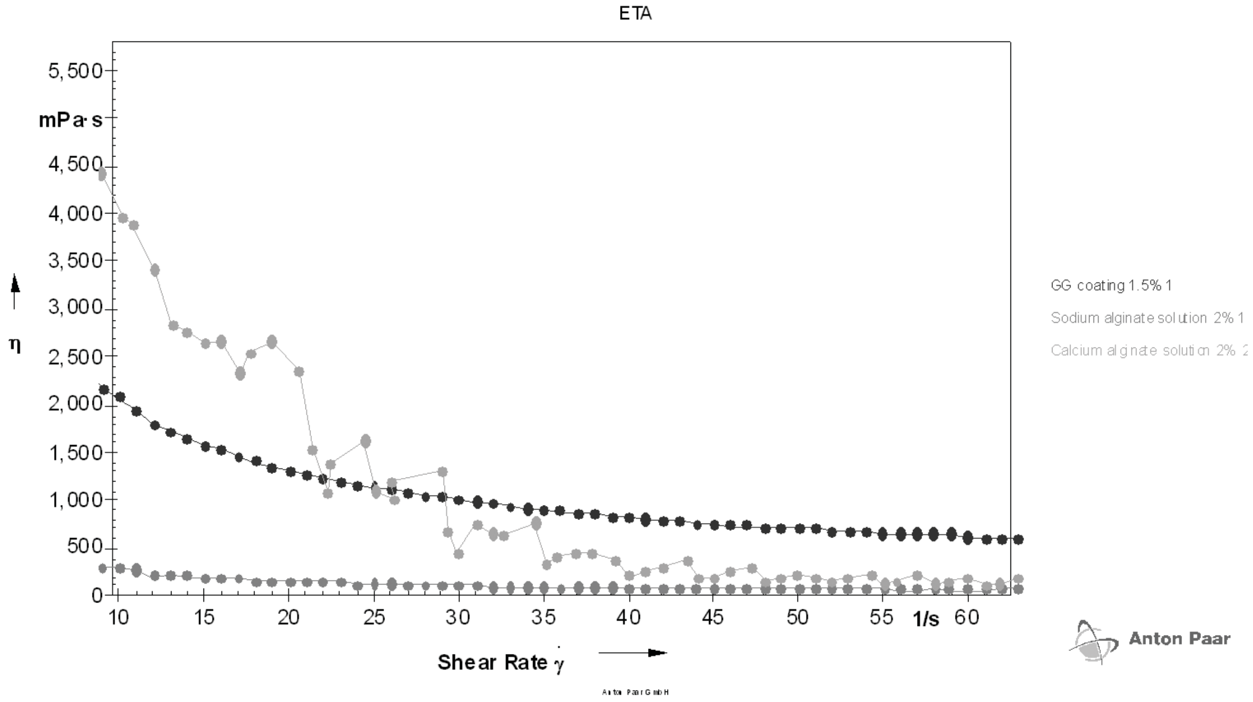

Fig. 1. The flow behavior pattern of the gels used for coating

of 1.591 (R^2 = 0.9913). Thus GG coating was found most effective in retaining moisture in fruits which in turn leads to better quality retention during storage. Better effectiveness of GG can be clearly attributed to its higher viscosity which effectively forms a continuous thick film over the surface of ivy gourd. The viscosity of 1.5% GG solution was determined to be 0.7 mPa.s, while alginate solution viscosity was 0.072 mPa.s. Upon reaction with calcium chloride also, the alginate gel was found to be less viscous (0.33 mPa.s). The flow behavior pattern of the gels shows an interesting pattern (Fig. 1). The gels show a shear-thinning behavior as expected. The GG solution was found more viscous than the alginate solution with viscosities as low as half at several shear rates. This can be very well understood as network formation in this solution has not yet started. Calcium alginate network formed on addition of equal amount of calcium chloride solution was found to have very high instantaneous viscosity, however upon increase in shear rate the viscosity decreased sharply. In fact beyond shear rate as low as $26s^{-1}$, the viscosity of calcium alginate was much lower than guar gum. Another contributory factor for better effectiveness of GG could be formation of homogenous and continuous film network on fruit surface. The same may not be said for alginate gums as the network formation occurs on the surface of fruit. Discontinuous and non-uniform gel network on the fruit surface may arise due to the fact that (egg box structured) calcium alginate network on fruit surface is dependent on the continuity of the base gel spread on fruit pericarp.

Hence it may be inferred that the viscosity of coating solution, thickness and uniformity of coating on individual fruit acts as the major determining factor for effectiveness of coating. As coating acts as physical barrier against loss of water by produce, its thickness and ability to interact with the polysaccharides on fruit pericarp need to be explored. Modification of coating material with these properties in mind may lead to more effective coating formulations.

Further, considering that most horticultural produce become unsalable as fresh produce after losing 3-10% of their weight (Ben -Yehoshua and Rodov, 2003), the shelf life of control fruits was 4 days at room temperature. Alginate coated fruits

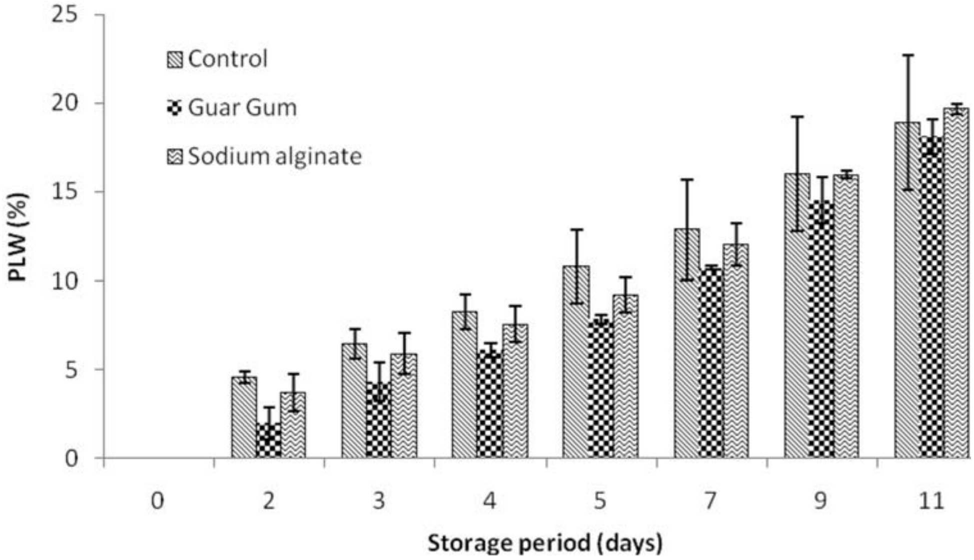

Fig. 2. Effectiveness of coating on reduction of PLW in ivy gourd
(* Each value is presented as the mean ± standard error (n = 3).)

could maintain saleable attribute for five days, while GG fruits could be sold upto seven days. Hence it can be inferred that shelf life of ivy gourd can be increased further by 3 days upon GG coating. As GG remains widely acceptable (GRAS) and the technique of application is also simpler, this treatment may be disseminated amongst growers for realizing better profits for their produce.

Higher effectiveness of GG over Alginate has also been reported by Saha *et al.*, (2016) for cucumber have found / recommended coating of GG for quality retention during storage. Similar effects of deferring weight loss were observed in papaya and table grapes (Ali *et al.*, 2011; Gao *et al.*, 2013).

Titratable Acidity

Most vegetables of Cucurbitaceae family show a gradual increase in acidity (decrease in pH) towards the ripening process. Increase in acidity was also observed in ivy gourd fruits towards the ripening phase. The increase was more perceivable because ivy gourd fruit comprises of thin epicarp, medium mesocarp and higher portion of endocarp. Acidity mostly accumulates near seedy portion of endocarp probably because of presence of bigger sized vacuoles and loosely arranged tissues. The ivy gourd stored at ambient condition exhibited a gradual increase in acidity upon storage period. While acidity increase was higher in control fruits, coated fruits tended to contain this increase. Saha *et al.* (2016) have also reported higher citric acid accumulation in endocarp portion of the untreated cucumber fruits in comparison to coated fruits. Lower acidity accumulation in vacuoles of coated fruits may be attributed to the ability of coating to reduce the respiration rate that in turn restricts ripening associated changes, including the acid biosynthesis pathway. Chiabrando *et al.* (2013) too have reported reduced accumulation of acidity in coated fresh cut nectarine fruits in comparison to control fruits.

Acidity of control fruits increased to 2.4 times during storage for 3 days, while corresponding increase in coated fruits was 1.6 and 1.3 times over the same period. Thereafter the acidity was found to decrease followed by an insistent level which may be attributed to its utilization for ripening associated secondary biosynthetic pathways for colour and flavor development. In case of Alginate coated fruits, the peak acidity was attained at 4-5 days of storage (Fig. 3), however the acidity was not found to decrease further. This may be attributed to the interference of the acid diversifying

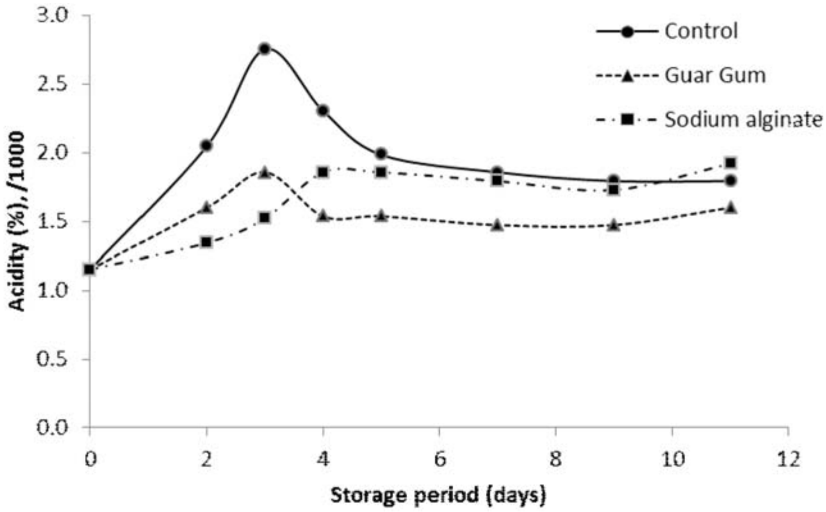

Fig. 3. Effect of Guar Gum and Sodium Alginate Coating on titratable acidity of ivy gourd stored at ambient temperature. Each value is presented as the mean ± standard error (n = 3)

metabolic pathways by higher amount of calcium or chloride ions. Further, detailed studies are required to explain this phenomenon. The lowest acidity was observed for GG coated fruits, with pattern of acidification and its utilization on the lines of control fruits but at much lower levels.

Textural measurements

Firmness of fruits

The ivy gourd fruits were found to decrease in firmness during storage. Ripening of the fruits led to associated increase in juiciness and decreased thickness of the epicarp. Fig. 3 depicts the observed decrease in firmness of ivygourds during storage. It can be clearly seen that the coated fruits retained higher firmness during storage with GG fruits retaining their firmness till 6 days of storage. While the control fruits' firmness decreased by 27% till 6th day, coated fruits still retained 83% of their initial firmness. On the ninth day however when more than 40-45% fruits turned reddish in hue, the firmness was found to decrease substantially. Similar

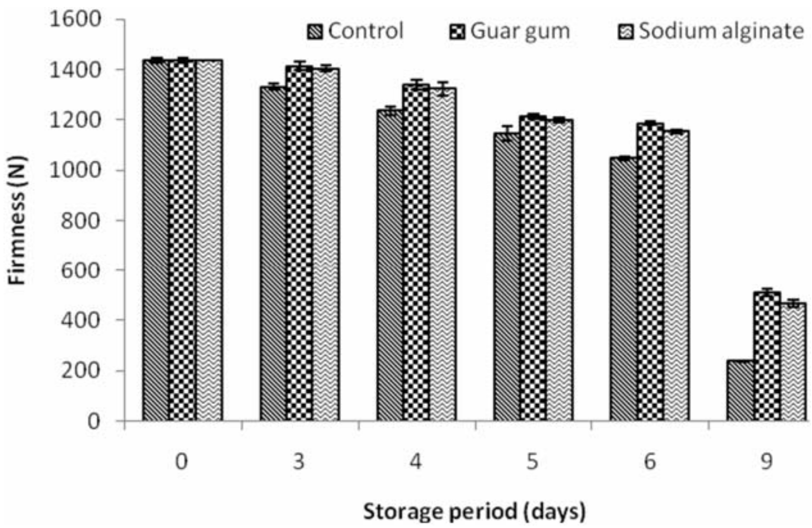

Fig. 4. Effect of Guar Gum and Alginate Coating on Firmness of ivy gourd stored at ambient temperature. Each value is presented as the mean ± standard error (n = 3)

observations have been reported for cucumber by Saha *et al.* (2016). Firmness retention is an indicator of freshness of vegetables with higher turgor pressure in cells responsible for structural integrity during storage. Turgidity being directly affected by retention of moisture on the fruit skin is understandably higher in case of coated fruits (Plate 1).

Toughness of internal flesh

The mesocarpic portion of the ivy gourd was found to soften during storage. While control fruits toughness tended to decrease gradually during storage period, the coated fruits tended to present a complex intermittent decrease followed by increased internal toughness after six

Plate.1: Morphological changes in ivy gourd during storage period

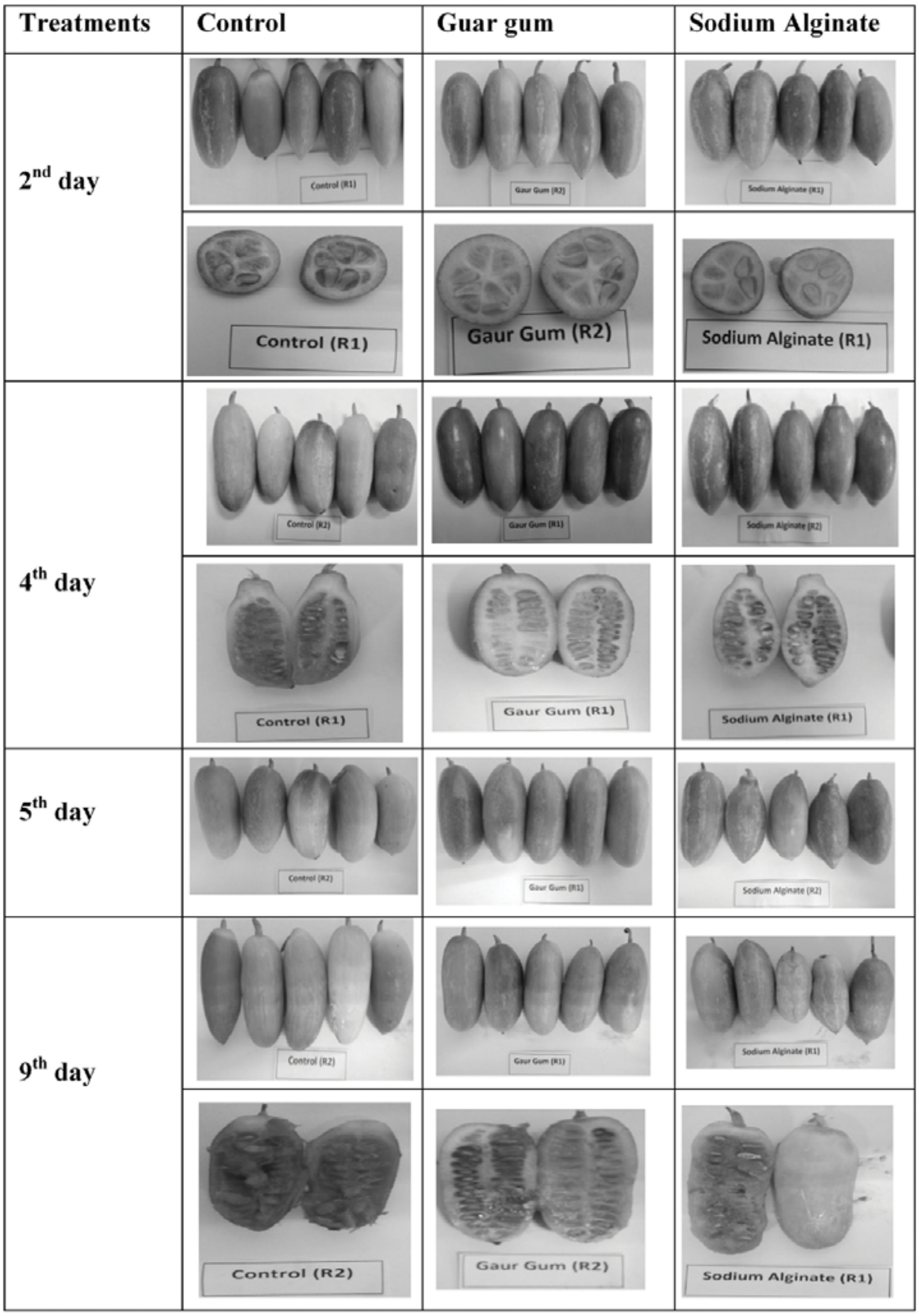

Table 1. Sensory characteristics and Color turning in stored Ivy gourd fruits.

		Storage period (days)							
Treatment	Parameter	0	2	3	4	5	7	9	11
Control	SS	9.0±00	8.0±0.0	7.0±0.0	7.0±0.0	6.7±0.3	6.5±0.7	5.5±0.7	5.0±00
	CF	0.0±00	1.5±0.7	1.5±0.7	2.2±0.7	3.5±0.7	4.0±1.4	5.0±1.4	7.0±1.4
Guar gum	SS	9.0±00	9.0±0.7	8.5±0.7	8.5±0.7	8.2±0.3	8.0±00	7.0±00	7.0±00
	CF	0.0±00	0.5±0.7	0.5±0.7	1.0±00	1.2±0.3	2.5±0.7	3.0±00	6.0±00
Alginate	SS	9.0±00	8.5±00	8.0±00	8.0±00	7.2±0.3	7.0±0.7	6.5±0.7	6.5±0.7
	CF	0.0±00	1.0±00	1.5±0.7	1.5±0.7	2.0±00	4.0±1.4	4.5±2.1	6.0±2.8

days of storage. Combined effect of disruptive effect on respiration and ripening of fruits could explain this tendency. On 4th day of storage, the mesocarp toughness was observed to be 51 kgf for control fruits while GG coated fruits yielded toughness in the range of 63.5 kgf. Alginate coated fruits retained even higher toughness (130.4 kgf) and were found to retain consistently higher toughness than GG coated fruits during the entire storage period. Upon prolonged storage for nine days, as the coated fruits visibly showed shriveling without ripening or colour turning (Plate 1), higher toughness values were recorded (~400 kgf). This is assumed to be because of desiccation of tissues deeper in the mesocarpic region.

Sensory characteristics

Sensory evaluation of ivy gourd was carried out by using 9 point hedonic scale. As storage period increased, marketability of fruits decreased. The results showed that over the storage period of 11 days the control fruits were acceptable for commercial sale upto 5 days while in Guar gum coated fruits were haiving marketable potential uptil 9th day. Alginate coated fruits remained marketeable for 8th day (Table 1.). These results correlated well with the physiological loss in weight and textural findings. Simultaneously, the number of coloured fruits was also measured along with the sensory evaluation. The result showed that the higher number of red colored fruit was found in control fruits compared to coated fruits.

Conclusion

Our results suggest that edible coatings positively affect the physicochemical properties of the ivy gourd. The coated sample shows significant difference in almost all parameters as compared to control sample. Ivy gourd coating with 1.5% guar gum, 2% sodium alginate was found to reduce the physiological loss in weight loss in firmness, increase in acid content and loss of sensory quality was achieved as compared to control samples. Thus, we conclude that gaur gum based edible coating was found satisfactorily enhance the shelf life and preserves fruit quality of ivy gourd stored at ambient conditions

References

Attanayake A.P., Jayatilaka KAPW and Mudduwa LKB. 2016. Anti-diabetic potential of ivy gourd (*Coccinia grandis*, family: Cucurbitaceae) grown in Sri Lanka: A review. *Journal of Pharmacognosy and Phytochemistry* **5**(6): 286-289.

Ben-Yehoshua S. and Rodov V. 2003. Transpiration and water stress. In: Bartz, J.A., Brecht, J.K. (Eds.), Postharvest Physiology and Pathology of Vegetables. Marcel Dekker, New York, pp. 111-159.

Chiabrando V. and Giacalone G. 2013. Effect of different coatings in preventing deterioration and preserving the quality of fresh-cut nectarines (cv Big Top). CyTA-*Journal of Food,* **11**(3): 285-292.

Chiabrando V., Giacalone G. and Rolle L. 2009. Mechanical behaviour and quality traits of high bush blueberry during postharvest storage. *J. Sci. Food Agric.* **89**: 989-992.

Debeaufort F., Quezada-Gallo J.A. and Voilley A. 1998. Edible films and coatings: tomorrow's packagings: A review. *Crit. Rev. Food Sci. Nutr.*, **38**: 299-313.

Kay D.E. 1979. Crop and product digest no 3-food legumes. London: *Tropical Products Institute;* pp. 72-85.

Kinh SAEH, Dunne C.P. and Hoover D.G. 2001. Preparation and preservation of apple pulp with chemical preservatives and mild heat. *J Food Prot* **28**(6): 111-114.

Kulkami S.G., and Vijayanand P. 2012. Effect of pretreatments on quality characteristics of dehydrated ivy gourd (*Coccinia indica* L.,). *Food and Bioprocess Technology* **5**: 593- 600.

Min S. and Krochta J.M. 2005. Antimicrobial films and coatings for fresh fruit and vegetables. In: Jongen, W.(Ed). Improving the safety of fresh fruit and vegetables, New York: CRC Press. pp. 455-492.

Olivas G.I. and Barbosa-Canovas G.V. 2005. Edible coatings for fresh-cut fruits. *Crit. Rev. Food Sci. Nutr.* **45**: 657-670.

Prem D., Singh S., Gupta P.P., Singh J., Kadyan S.P.S. 2005. Callus induction and de novo regeneration from callus in guar (*Cyamopsis tetragonoloba* L. Taub.) *Plant Cell Tiss Org.* **80**: 209-214.

Saha A., Tyagi S., Gupta R.K. and Tyagi Y.K. 2016. Guar gum based edible coating on cucumber (*Cucumis sativus* L.). *European Journal of Pharmaceutical and Medical Research* **3**(9), 558-570.

Suresh-Babu K.V. and Rajan S. 2001. A promising triploid of little gourd *J. Trop. Agric.* **39**:162-163.

Tripathi K.D. 2001 Essentials of Medical Pharmacology. 4th ed. New Delhi. Jaypee brother's Medical publisher, pp 17-26.

Umamaheswari M. and Chatterjee T.K. 2008. In vitro antioxidant activities of the fractions of *Coccinia grandis* L. leaf extract. *African Journal of Traditional, Complementary and Alternative Medicines* (1): 61-73

Whistler R.L. and Hymowitz T. 1979. Guar: agronomy, production, industrial use, and nutrition. West Lafayette: Purdue University Press.

Wu Y., Weller C.L., Hamouz F., Cuppet S. and Schnepf M. 2002. Development and application of multicomponent edible coatings and films: A review. *Adv. Food Nutr. Res.* **44**: 34-39.

Zhu X., Wang Q.M., Cao J.K. and Jiang W.B. 2008. Effects of chitosan coating on postharvest quality of mango (*Mangifera indica* L. CV. Tainong) vegetables. *J Food Process Preserv,* **32**(5): 770-784.