A-5725
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REVIEW ARTICLE Indian Journal of Agricultural Research

Edible Coatings in Extending the Shelf Life of Fruits: A Review

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10.18805/IJARe.A-5725

ABSTRACT

Post-harvest losses of fruits are a matter of concern for all those nations whose economy is based on horticulture. Fruits face tremendous loss due to old-fashioned preservation practice and ignorance about the preservation strategies. Consumers around the world demand for food of high-quality, without chemical preservatives and an extended shelf life. New technological advances in edible coatings for food may hold promise in extending shelf life, reducing packaging layers, meeting food safety and quality requirements. Among various coatings, edible coatings have been proven one of the best biologically safe preservative coatings for different types of foods because of its film-forming properties, antimicrobial actions, bio degradability and biochemical properties. It acts as a natural barrier to moisture and oxygen, which are the main agents of deterioration of fruits and vegetables. Edible coatings have the ability to prolong shelf life of the fruits by minimizing the rate of respiration and maintaining quality attributes. It has antifungal and antibacterial properties which provide a defensive barrier against microbial contamination. The present review describes about the different edible coatings and their potential application for enhancing the postharvest life and quality of different types of fruits.

Key words: Edible coatings, Fruits, Shelf life.

Major losses in quality and quantity of fresh fruits occur between harvest and consumption. Savings obtained through reduction of postharvest fruit losses is regarded as ‘a hidden harvest’. Through a better understanding of the respiration process of fresh fruits, several techniques have been developed that are successful in extending shelf life. Consumers around the world demand for food of high-quality, without chemical preservatives and an extended shelf life. Many storage techniques have been developed to extend the marketing distances and holding periods for commodities after harvest. Emerging research shows polysaccharides, bacteriocins, essential oils, enzymes, proteins and lipids are all natural coatings that have unrealized potential in food preservation. Among various methods to extend the post-harvest life of fruits, the use of the edible coatings has gained a good momentum.

The application of edible coatings is increasingly demonstrating to be a relatively new and simple technology effective in preventing the appearance and textural deterioration of several products. Edible coatings based on cellulose gums effectively delay ripening in some climacteric fruits like mangoes, papayas and bananas and significantly reduce enzymatic browning on sliced mushrooms (Nisperos-Carriedo *et al.,* 1991). Several polysaccharides (chitosan, alginate, methylcellulose or pectin) and proteins (casein, collagen, gelatin, phaseolin, zein, soy or whey proteins), or mixtures of them, were shown to give rise to edible films effective as water vapour and gas barriers for a wide range of food products and as carriers for antimicrobials. In particular, antimicrobial containing films are recently gaining potential interest in reducing the deleterious effects caused by minimal cut processing of fresh fruits and vegetables (Conte *et al.*, 2009). Some of the most commonly used antimicrobials include benzoic acid, sorbic acid, lysozyme, bacteriocins and plant-derived secondary metabolites, such as essential oils and phytoalexins.

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How to cite this article: Hazarika, T.K., Lalhriatpuia, C., Ngurthankhumi, R., Lalruatsangi, E., Lalhmachhuani, H. (2021). Edible Coatings in Extending the Shelf Life of Fruits: A Review. Indian Journal of Agricultural Research. DOI: 10.18805/IJARe.A-5725.

Submitted: 09-12-2020 **Accepted:** 23-04-2021 **Online:** 12-05-2021

The mechanism by which edible coatings preserve fruits and vegetables is the establishment of a modified atmosphere around the product, which serves as a partial barrier to O_2 and CO_2, water vapour and aroma compounds, decreasing the respiration rate of the fruit and water loss and preserving texture and flavor (Olivas *et al*., 2008). In addition to the use of edible coatings, food additives can be added to plant foods to control detrimental reactions (Rojas-Graü *et al*., 2009). An edible coating is a thin layer that is deposited on the surface of a fruit and is co - consumed. It is used to improve handling properties, prevent moisture loss, to increase the shelf life and to reduce the need of packaging material during transport (Verma *et al*., 2012). Edible coatings act as moisture and oil barrier at low to intermediate RH because the polymers make effective hydrogen bonds. Ideal edible coatings have good eating properties, acceptable colour, odour, taste, flavor and texture and also act as barrier for microbes. The use of coating has gained importance in reducing the moisture loss and maintaining firmness (Farooqhi *et al*.,1988 and Chouhan *et al*., 2005).

Effect of chitosan

Chitosan is modified, natural biopolymer derived from chitin, is obtained from waste products of the shellfish exoskeletons or the cell walls of some microorganisms and fungi and it has shown great aptitude for their application in food preservation. It is a cationic polysaccharide with a high molecular weight and a linear polymer which is composed of *β*-1, 4-linked glucosamine (GlcN) with various quantities of N-acetylated GlcN residues. Chitosan has antibacterial and antifungal properties and is used for food protection. Antimicrobial films can be made from chitosan blended with essential oils and clays. Chitosan films with different combinations can increase the shelf life of food.

Recently, chitosan has received increased attention for its commercial applications in the biomedical, food and chemical industries. Use of chitosan in food industry is readily seen due to its several distinctive biological activities and functional properties. The antimicrobial activity and film-forming property of chitosan make it a potential source of food preservative or coating material of natural origin (No *et al*., 2007). It has the property to create a semipermeable barrier that controls gas exchange and reduce water loss, thereby maintaining tissue firmness and reducing microbial decay of harvested fruit and vegetables (Alvarez *et al*., 2013).

Jiang and Li (2001) studied the effects of chitosan coating in extending postharvest life of longan fruits as well as investigated the maintenance of their quality. Their study revealed that the application of chitosan coating reduced respiration rate and weight loss, delayed the increase in PPO activity and the changes in colour and eating quality and partially inhibited decay of fruit during storage. Furthermore, increasing the concentration of chitosan coating enhanced the beneficial effects of chitosan on postharvest life and quality of the fruit.

The application of chitosan coating delayed discoloration associated with reduced activities of PAL, PPO and POD as well as lower total phenolic content and slowed down the loss in eating quality associated with higher contents of total soluble solids, titratable acidity and ascorbic acid of fresh-cut CWC. Disease development of the fresh-cut CWC-treated chitosan coating was also inhibited compared to the control. Increasing the concentration of chitosan coating markedly enhanced the beneficial effects (Pen and Jiang, 2003).

Dong *et al*. (2004) reported that application of chitosan coating retarded weight loss and the decline in sensory quality, with higher contents of total soluble solids, titratable acid and ascorbic acid and suppressed the increase in activities of PPO and POD and effectively maintained quality attributes and extended shelf life of the peeled fruits of litchi.

Application of chitosan coating delayed the decrease in anthocyanin content, increase in PPO activity and changes in colour index as well as reduction in eating quality decrease in concentrations of total soluble solids and titratable acidity and partially inhibited decay. In addition, treatment with chitosan coating was potential for shelf life extension at ambient temperature when litchi fruits were removed from cold storage (Jiang *et al*., 2005).

Munoz *et al*. (2008) revealed that in strawberry fruits, the chitosan coating reduced respiration activity, thus delaying ripening and the progress of fruit decay due to senescence. Chien *et al*. (2013) reported that chitosan coating had the ability to maintain the lightness of the sliced papayas. The chitosan coating on the sliced papaya effectively retarded water loss and inhibited the growth of microorganisms. The results reveal that applying a chitosan coating effectively maintained the quality attributes and prolonged the shelf life of the sliced papayas.

Effect of *Aloe vera* Gel

Aloe vera is a well known plant for its marvellous medicinal properties. *Aloe vera* gel has been proven one of the best edible and biologically safe preservative coatings for different types of foods because of its film forming properties, antimicrobial actions and biodegradability and biochemical properties. *Aloe vera* gel forms a protective layer against the oxygen and moisture of the air and inhibiting the action of micro-organisms that cause food borne illnesses through its various antibacterial and antifungal compounds (Serrano *et al*., 2006). *Aloe vera* gel based edible coatings have been shown to prevent loss of moisture and firmness, control respiratory rate and maturation development, delay oxidative browning and reduce microorganism proliferation in fruits.

Serrano *et al*. (2006) coated grapes fruits with *Aloe vera* gel and their study revealed that uncoated clusters showed a rapid loss of functional compounds, such as total phenolics and ascorbic acid. These changes were accompanied by reduction of the total antioxidant activity (TAA) and increases in total anthocyanins, showing an accelerated ripening process. On the contrary, table grapes coated with *Aloe vera* gel significantly delayed the above changes, such as the retention of ascorbic acid during cold storage or SL. Consequently, *Aloe vera* gel coating, a simple and non-contaminating treatment, maintained the functional properties during postharvest storage of table grapes.

Romero *et al.* (2006) studied the effect of *aloe vera* gel coatings on postharvest treatment of sweet cherry and their study revealed that fruits treated with *Aloe vera* gel decreased respiration rate, slowed down weight loss and colour changes, reduced softening and ripening, stem browning and decreased microbial populations significantly as well extended storage period.

Singh *et al*. (2011b) studied the effect of different concentrations of *Aloe vera* gel coatings on refrigerated strawberry quality and shelf-life and their study revealed that strawberries treated with *Aloe vera* gel (1: 3 ratio) significantly reduced weight loss, maintained colour, firmness, quality characteristics (TSS, acidity and ascorbic acid) and ultimately extended storability up to 16 days. The sensory analysis for taste, aroma and flavour further confirmed their findings.

Padmaja and Bosco (2014) reported that *Aloe vera* gel of 1:3 ratios with a dipping period of 5 minutes effectively inhibited the undesirable physicochemical and physiological changes during storage of Jujube packaged in LDPE film, extending its shelf life to 45 days under refrigerated conditions. This edible coating along with surface cleaning of fruit with potassium meta bisulphate was able to reduce the initial microbial counts for both bacteria and fungi, which significantly increased the shelf life of edible coated jujube fruits to 45 days over storage. Jujube fruits with above treatment scored appreciable sensory scores as compared to control.

Nasution *et al.* (2015) studied the effect of additives in *Aloe vera* gel (AV) coating on fresh-cut guava stored at 5°C and 75-80% relative humidity. The additives used were 1.5% ascorbic acid (AA), 2% calcium chloride ($CaCl_2$) and 0.2% potassium sorbate (PS). The coated samples had less change in the color lightness and yellowness compared to the uncoated sample. AV + AA +PS-coated guava was the most acceptable sample with respect to sensory acceptance. Moreover, it gave the highest ascorbic acid content.

Sharmin *et al*. (2015) studied the effects of *aloe vera* gel coating on storage behaviour of papaya at room temperature (29°C-31°C). Among the physico-chemical parameters, colour, physical changes, total weight loss and TSS contents increased significantly, whereas moisture content, vitamin C and titratable acidity decreased during storage. The overall results showed the superiority of 1.5% *aloe vera* gel coating in extending the shelf-life of papaya up to 15 days compared to that of 0.5%, 1% *aloe vera* gel coating and control papaya.

Ali *et al.* (2016) studied the effect of *Aloe vera* coatings on shelf life of grapes. Their results revealed that 20 per cent *Aloe vera* coating gave the best visual and physicochemical results and most effective and appropriate for the extension of shelf life of grapes. It was also found that the use of low temperature storage in combination with edible coating and packaging extends marketability by reducing moisture loss.

Effect of paraffin wax

Paraffin wax is a white or colourless soft solid derivable from petroleum, coal or oil shale that consists of a mixture of hydrocarbon molecules containing between twenty and forty carbon atoms. It is solid at room temperature and begins to melt above approximately 37°C (99°F); its boiling point is >370°C (698°F).

Sindhu *et al.* (2009) studied the effect of waxing on fruits of pear cv. Punjab Beauty. Their study revealed minimum PLW, shrivelling and spoilage percentage in the waxed fruits packed in the CFB cartons and maximum in non-waxed fruits packed in wooden boxes. No core browning was observed up to 60 days of cold storage in waxed fruits packed in CFB cartons. Waxed fruits could be cold stored for 75 days in CFB cartons with minimum weight loss, spoilage, excellent appearance and better fruit quality. CFB packaging proved better than wooden boxes.

Singh *et al.* (2011a) studied the effect of waxing on weight loss, decay loss and the chemical changes associated with ripening of purple passion fruit. The shelf life of paraffin waxed fruits was 25 days with maximum juice density and maximum sugars of the fruits.

Effect of CMC (Carboxy Methyl Cellulose)

CMC or cellulose gum is a cellulose derivative with carboxy methyl groups ($-CH_2-COOH$) bound to some of the hydroxyl groups of the glucopyranose monomers that make up the cellulose backbone. It is often used as its sodium salt, sodium carboxy methyl cellulose.

Togrul and Arslan (2004) treated peach and pear fruits with different compositions of emulsions to extend shelf-life of fruits. The coating of peach and pear surfaces with emulsions containing CMC extended the shelf-life of peach and pear to 12 and 16 days, respectively. Hussain *et al.* (2010) used Carboxymethyl cellulose (CMC) coatings alone and in combination with gamma irradiation for maintaining the storage quality and extending shelf life of pear. CMC coating in combination of 1% w/v CMC and 1.5 kGy irradiation proved significantly ($P \leq 0.05$) effective in maintaining the storage quality and delaying the decaying of pear.

There is increasing public interest in development of edible natural biodegradable coatings to replace the currently used commercial synthetic waxes for maintaining postharvest quality of citrus fruits. Arnon *et al.* (2014) studied the efficacy of carboxy methyl cellulose (CMC) and chitosan in preserving postharvest quality of various citrus fruits, including ‘Or’ and ‘Mor’ mandarins, ‘Navel’ oranges and ‘Star Ruby’ grapefruit after simulated storage and marketing. In all citrus species, it was found that the CMC/chitosan bilayer coating was equally effective as the commercial polyethylene wax in enhancing fruit gloss. Furthermore, the CMC/chitosan bilayer coating slightly increased fruit firmness, especially of oranges and grapefruit, but was mostly not effective in preventing post-storage weight loss.

CONCLUSION

Due to lack of proper post- harvest handling and traditional preservation practices most of the fruits get lost after harvest. Consumers always demand for food of high-quality, without chemical preservatives and with an extended shelf life. To effectively extend the shelf life of postharvest fruits and vegetables, edible coatings act as relatively convenient and safe measures which are invariably used in food industry. In addition, these coatings are totally harmless to the environment. In fact it can be considered as a green alternative to synthetic coatings and other postharvest chemical treatments.

The edible coatings would have a wide prospect in the preservation of post-harvest fruits and vegetables in future.

REFERENCES

Ali, J., Pandey, S., Singh, V. and Joshi, P. (2016). Effect of coating of *Aloe vera* gel on shelf life of Grapes. Current Research in Nutrition and Food Science. 4: 58-68.

Alvarez, M.V., Ponce, A.G. and Moreire, M.R. (2013). Antimicronbial efficiency of chitosan coating enriched with bioactive compounds to improve the safety of fresh cut broccoli. Food Science Technology. 50: 78-87.

Arnon, H., Zaitsev, Y., Porat, R. and Poverenov, E. (2014). Effects of carboxymethyl cellulose and chitosan bilayer edible coating on postharvest quality of citrus fruit. Postharvest Biology and Technology. 87: 21-26.

Chien, P.J., Lin, H.R. and Su, M.S. (2013). Effects of Edible Micronized Chitosan Coating on Quality and Shelf Life of Sliced Papaya. Food and Nutrition Sciences. 4: 9-13.

Conte, A., Scrocco, C., Brescia, I. and Del Nobile, M.A. (2009). Packaging strategies to prolong the shelf life of minimally processed lampascioni (*Muscari comosum*). Journal of Food Engineering. 90: 199-206.

Dong, H., Cheng, L., Tan, J., Zheng, K. and Jiang, Y. (2004). Effects of chitosan coating on quality and shelf life of peeled litchi fruit. Journal of Food Engineering. 64: 355-358.

Farrooqhi, W.A., Salih, A.M. and Zain -Ul-Abdin (1988). Effect of wax coatings on the physiological and biochemical aspects of Kinnow Fruit. Pakistan Journal of Scientific and Industrial Research. 31: 142-145.

Hussain, P.R., Meena, R.S., Dar Mohd, A. and Wani Ali, M. (2010). Carboxymethyl cellulose coating and low-dose gamma irradiation improves storage quality and shelf life of Pear (*Pyrus communis* L., cv. Bartlett/William). Journal of Food Science. 75: 586-596.

Jiang, Y. and Li, Y. (2001). Effects of chitosan coatings on postharvest life and quality of fruits. Food Chemistry. 73: 139-143.

Jiang, Y., Li, J. and Jiang, W. (2005). Effects of chitosan coating on shelf life of cold-stored litchi fruit at ambient temperature. LWT. 38: 757-761.

Munoz, P.H., Almenar, E., Valle, V.D., Velez, D. and Gavara, R. (2008). Effect of chitosan coating combined with postharvest calcium treatment on strawberry (*Fragaria × ananassa*) quality during refrigerated storage. Food Chemistry. 110: 428-435.

Nasution, Z., Wei Ye, J. Ng., Hamzah, Y. (2015). Characteristics of fresh-cut Guava coated with *Aloe vera g*el as affected by different additives. Kasetsart Journal of Natural Science. 49: 111-121.

Nisperos-Carriedo, M.O., Baldwin, E.A., Shaw, P.E. (1991). Development of an edible coating for extending postharvest life of selected fruits and vegetables. Proceedings of Florida State Horticultural Society. 104: 122-125.

No, H.K., Meyers, S.P., Prinyawiwatkul, W. and Xu, Z. (2007). Applications of Chitosan for Improvement of Quality and Shelf Life of Foods: A Review. Journal of Food Science. 72: 87-100.

Olivas, G.I., Davila-Avina, J.E. Salas-Salazar N.A. and Molina, F.J. (2008). Use of edible coatings to preserve the quality of fruits and vegetables during storage. Stewart Postharvest Review. 4: 1-9.

Padmaja, N. and Bosco, S.J.D. (2014). Preservation of jujube fruits by edible *Aloe vera* gel coating to maintain quality and safety. Indian Journal of Scientific Research and Technology. 2: 79-88.

Pen, L.T. and Jiang, Y.M. (2003). Effects of chitosan coating on shelf life and quality of fresh-cut Chinese water chestnut. Lebensm.-Wiss. U.-Technology. 36: 359-364.

Rojas-Graü, M.A., Oms-Oliu, G. Soliva-Fortuny R. and Martin-Belloso, O. (2009). The use of packaging techniques to maintain freshness in fresh-cut fruits and vegetables: a review. International Journal of Food Science and Technology. 44: 875-889.

Romero, D.M., Alburquerque, N., Valverde, J.M., Guill´en, F., Castillo, S., Valero, D. and Serrano, M. (2006). Postharvest sweet cherry quality and safety maintenance by *Aloe vera* treatment: A new edible coating. Postharvest Biology and Technology. 39: 93-100.

Serrano, M., Valverde, J., Guillen, F., Castillo, S., Martinez-Romero, D. and Valero, D. (2006). Use of Aloe vera gel coating preserves the functional properties of table Grapes. Journal of Agricultural and Food Chemistry. 54: 3882-3886. doi: 10.1021/jf060168p.

Sharmin, M.R., Islam, M.N. and Alim, M.A. (2015). Shelf-life enhancement of papaya with *Aloe vera* gel coating at ambient temperature. Journal of Bangladesh Agricultural University. 13: 131-136.

Sindhu, G.S., Dhillon, W.S. and Mahajan, B.V.C. (2009). Effect of waxing and packaging on storage of pear cv. Punjab Beauty. Indian Journal of Horticulture. 66: 239-44.

Singh, A., Yadav, D.S., Patel, R.K., Nath, A. and Bhuyan, M. (2011a). Wax coating and padding materials influence quality and shelf-life of purple passion fruit during storage. Indian Journal of Horticulture. 68: 246-249.

Singh, D.B., Singh, R., Kingsly, A.R.P. and Sharma, R.R. (2011b). Effect of *Aloe vera* oatings on fruit quality and storability of strawberry (*Fragaria×ananassa*). Indian Journal of Agricultural Sciences. 81: 407-412.

Togrul, H. and Arslan, N. (2004). Extending shelf-life of peach and pear by using CMC from sugar beet pulp cellulose as a hydrophilic polymer in emulsions. Food Hydrocolloids. 18: 215-226.

Verma A., Parihar, P. and Sharma, A. (2012). Effect of Edible Coatings on Quality Attributes of Guava varieties L-49 and Allahabad Safeda during Initial stage of Storage. Agricultural Science Digest. 32 (4): 319-322.

Chauhan S.K., Thakur, K.S. and Kaushal, B.B.L. (2005). Effect of post-harvest coating treatments on the storage behaviour of starking delicious apple fruits under evaporative cool chamber. Acta Horticulture. 696: 473-478.