

Review Article

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Edible Coatings in Fruits -A Review

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ABSTRACT

Low shelf life is the major problem in fruits, which affects consumer preference and marketability. Transpiration process starts after harvesting of fruits from plant, which lead to loss of quality along with shriveling, and ultimately shortens the life of the fruit. Many research experiments are conducted related to storage and packaging for increasing the shelf life of fruits like modified and controlled atmospheric storage/packaging, coatings. Coatings provide an extra protection layer to the fruit and help in increasing shelf life. Edible coatings made with edible materials that act as a barrier to water vapor and gases. These coatings act as the best alternatives to natural coverings by improving external appearance and changing internal atmosphere, which ultimately influences the shelf life. Application of semipermeable coatings reduces moisture loss, respiration, and transpiration, which increases the storage life of the commodity. The addition of food additives like pigments, antioxidants, antimicrobials, and antifungal substance helps in reducing postharvest decay in fruits.

Keywords

Edible and semipermeable coatings, Food additives, Fruits, Shelf life

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Introduction

Consumers are demanding, globally, for high quality food which is without chemical substances and having stretched shelf life (Lin and Zhao, 2007). On the contrary, fruits are highly perishable in nature, as they contain enough quantity of water. After their harvesting, transpiration process starts

quickly, which lead to loss of quality along with shriveling and ultimately shortens the life of the fruit. Problems like flaccidity, shriveling, wilting and decay etc. occur during postharvest management of fruits that ultimately influence marketability of the same including consumer preference. Today different kinds of preservation technologies are available for the post-harvest

management. A potential awareness among the consumers concerning health aspect has raised consumers' attention towards natural plant extracts, to be used as coating material (Bhat *et al.*, 2011). Such kind of post-harvest technology, aims at encompassing storage/shelf life of fruits by using natural plant-products. These edible coatings have drawn substantial attention in recent times as they have lot of advantages over synthetic/chemicals ones. They offer good alternative as they improve external appearance, and adjust the internal atmosphere of fruits. Moreover, such kind of postharvest losses can be lessened by stretching shelf life by checking microbial infection, transpiration and respiration rate and preventing disorganization of cell membranes (Bisen and Pandey, 2008). Such coatings act as decent oxygen and lipid blockade at lower RH because the polymers can efficiently make hydrogen bonds. These coatings also have antimicrobial or antioxidants property that reduces the decay without influencing quality. Today various kinds of chemical fungicides are the principal means for regulating postharvest fungal decay of fruits. An attempt in lessening, postharvest loss of tomato fruit caused by *Phytophthora infestans* is good example, where certain fungicidal coatings are discussed (Ghatak *et al.*, 2015). Adewoyin (2017) observed longer shelf life of pepper fruits, which are packaged in the aluminum foil than others and the main aim of this article was to assemble and update the statistics accessible on plant based natural coatings for quality, safety, and functionality of fruits. Such edible coatings are biodegradable and offer a good alternative to the other packaging. Therefore, the precise knowledge of such developments is of vital significance in developing effective tactics to improve quality including shelf-life of perishable natured fruits. Edible coating is well-defined as a thin layer edible material applied to the fruit surface in addition to or as

a replacement for natural protecting waxy layers and to offer a barrier to moisture, oxygen, and solute movement for the food. Edible coating is an ecofriendly technology applied on many products to control gas exchange or oxidation processes and moisture transfer. They offer an extra protecting covering to the commodity and furthermore give the similar results as in case of modified atmosphere storage by adjusting internal gas structure. Nawab *et al.*, (2017) told that the coatings form a semi-permeable barrier to gas exchange and water vapor, results in alteration of respiration rate, reduction of weight loss, and delay of senescence. In addition to acting as gas and moisture barriers, the coatings control microbial growth, preserve the texture, color and moisture of the product, and thus effectively prolong the shelf life of the product. Incorporation of other active ingredients in edible films and coatings enhances the safety and nutrition value of the fruits and vegetables. Food grade extracts including flavouring agents, pigments, antioxidants and antimicrobials can be added to modify their structure and advance characters of coatings, which when applied on produce increases its quality.

Methods for coating

The coating is applied through various methods contains dipping, brushing or spraying, on the food surface in order to make a modified atmosphere. Edible coatings can be applied by the simple methods like dipping products in coating materials and let them dry and solidify. Atieno (2019) observed no significant difference between spraying and dipping methods on cassava root to maintain post-harvest quality with xanthan/guar gum. Thus, edible films and coatings do not change traditional packaging materials but provide an extra support to fruits for their preservation.

Effect of edible coatings on fruit crops

Effect on external appearance and glossiness

External appearance is an important aspect of the horticulture commodity. Rough physical management of fruits at postharvest phase is one of the major reasons to destroy of natural wax layer and bruising injury during the packing and transport operations. The edible coating offers a physical barrier between the fruit surface and the external surrounding of produces, which eventually lead to preservation of postharvest quality. Javanmard, (2011) observed whey protein concentrate show high rate of glossiness, taste, color and minimum weight loss over gellan gum coatings.

Effect on fruit firmness and softening

Edible coating keeps the firmness by evading excessive transpiration and respiration those involved directly in lessening storage reserves. Edible coating directly shows effect on fruit firmness by decreases the activity of cell wall degrading enzymes and delaying ripening. It is known that calcium directly affects fruit firmness thus the incorporation of calcium in the edible coating was also showed high effective in increasing fruit firmness. Zhang *et al.*, (2018) discovered weight loss of the apricot was significantly reduced by the soybean isolated protein combined with chitosan along with preventing decrease in firmness and benefiting external characters.

Effect on weight loss of fruits

The weight of horticulture product governs the returns of farmers. Transpiration is the main reason of loss of weight of particular product, which is determined by the change of water vapour pressure between the fruit and the atmosphere. Edible coatings perform as an

added barrier between the fruit surface and atmosphere, by which transpiration occurs. Hazrati (2017) reported that coating of peaches with aloe-vera L gel showed significantly positive effects on weight loss, change in color and TSS over control.

Impact on physiology of fruit

Physical state of the fruit is altered by the factor like fruit respiration, ethylene production rate etc. which plays important role in altering fruit physiology. An edible coating shows direct as well as indirect effect on the physiology of harvested commodities. Tesfay (2017) demonstrated that avocado fruits (varieties Hass and Geem) showed lower respiration, ethylene production and higher firmness when coated with 1% carboxyl methylcellulose, moringa leaf and seed extract throughout the storage period.

Ethylene production and respiration

The edible coating stops the entry of oxygen inside the fruit which controls the ethylene production and drops respiration rate. Thus, the fruits remain fresh, firm, and nutritious for a longer period and their shelf life almost doubles. The natural coating on fruits, the type of added coating and amount of coating will extent the formation of the internal modified atmosphere (O₂ and CO₂). Nasrin (2020) observed the lemon coated with coconut oil-beeswax (90:10 and 80:20) or only coconut oil coating and kept in MAP showed extending in shelf life and quality maintenance like colour retaining, reducing ethylene production, respiration rate, weight loss and shriveling and preserved moisture content and firmness.

Biochemical parameters

Other than physical and physiological changes, edible coatings have a direct and

indirect part in altering the biochemical constituents, which are responsible for taste and shelf life of the fruits. These include viz. titratable acidity, total soluble solids and ascorbic acid. Hosseini (2018) observed the reducing weight loss, positive effect in maintaining vitamin C, and good sensory acceptability of kumquats which are treated with chitosan coatings incorporated with savory and/or tarragon essential oils.

Total phenolic and antioxidants

Presence of phenolic and antioxidants influences the shelf life of the fruits and vegetables. Presence of these compounds increases the resistance to various postharvest quality maintain factors. Shelf life of the fruits and vegetables increased by antioxidants from internal present and also by external application. Edible coatings have effect and ability to alter/ increase the antioxidant and also total phenolic content in harvested horticultural commodities shows same effect as antioxidants. Li (2017) observed positive effects on fruit quality and highest relative activities of antioxidants enzymes in chitosan based strawberry fruits over alginate and pullulan coatings,

Lipid peroxidation and enzymatic activities

Edible coating shows influence on the cell wall related enzymes activity. The effect is reported in case of enzymes such as polyphenol oxidase, phenylalanine ammonia lyase, and malondialdehyde which have an important role in cell wall degradation and peel browning. Edible coatings also regulate the process of lipid peroxidation which is responsible for cell wall breakdown and free radicals' generation which eventually affects postharvest quality. Panahirad (2020) observed the plum fruits coated with 1% carboxymethylcellulose, 1.5% pectin-based coatings and 0.5% pectin+ 1.5% carboxymethylcellulose combination preserved

firmness and improved anthocyanin, total phenols, antioxidant capacity, flavonoid content and peroxidase content and delayed vitamin C loss, titratable acidity and decreased enzymatic activity such as polyphenol oxidase and polygalacturonase.

Classification of commercial forms of edible coatings

Gutiérrez (2018) stated that edible coatings are produced from polymers which are categorized as hydrocolloids, lipids and their compounds. According to Valencia and do Amaral Sobral (2018) polysaccharides and protein are the vastly used structural resources for edible coatings. They are more tasteless, transparent and neutral, than those produced from lipids. Garrido *et al.*, (2018) stated that edible coatings and films formed from polysaccharides or proteins usually provides good mechanical strength and good oxygen barriers. However, these materials are hydrophilic in nature, thus they are considered as poor water vapor barriers.

On the other hand, lipids (fats and oils) are excellent hydrophobic materials and less permeable to water vapor. Galus and Kadzińska (2015) stated that the hydrophilic character of polysaccharide and protein-based materials can be improved efficiently by combination of lipids.

In recent studies of Merino *et al.*, (2019) on edible film preparing materials, the combination of different proteins, lipids and/or polysaccharides can be observed. The purpose of these researches is to use different properties of each factor in order to get new coating materials with better functional properties which depend on their compatibility and miscibility.

According to Álvarez *et al.*, (2017) among polysaccharides, lipids and proteins, additional composites are generally required

in order to provide flexible and continuous structure of coatings and films. Plasticizers are used to bound negative properties such as brittleness cracking or fragility. Medina *et al.*, (2016) stated that oligosaccharides, lipids, and polyphenols are different kinds of plasticizers used in edible coatings and are hydrocolloids. In addition, water plays an important role as a plasticizer and shows difference in physical properties of films.

Salgado *et al.*, (2015) stated that the use of bioactive ingredients and biopolymers obtained from agricultural waste or byproducts encourages the development of these global friendly resources which can substitute or at least bound the use of conventional plastics.

Galus *et al.*, (2020) review about the new materials in the preparation of the edible coatings and films like plant residues, gums and flours and their preparation and applications.

Polysaccharides derived edible coatings

Polysaccharide based coatings are highly used edible coatings in fruits and vegetables. These polysaccharides are prepared from various plant species. These coatings have ability to prevent gases exchange, ability to reduce the water loss, and controls ripening and senescence. Crystalline property of some polysaccharides is reason for cross linkage which helps in a better coating. The most commonly used polysaccharide-based coatings include cellulose, chitosan and gums prepared from various plant species. Panahirad *et al.*, (2020) observed improvement of postharvest quality of plum by application of different polysaccharide based coatings, stated application of 1% carboxymethylcellulose, 1.5% pectin based edible coatings and 0.5% pectin+ 1.5% carboxymethylcellulose combinations

improved anthocyanin, total phenols and flavonoid contents, antioxidant capacity and POD activity, delayed titratable acidity and vitamin C loss, and decreased enzymatic activities such, polyphenol oxidase and polygalacturonase.

Cellulose based edible films

Cellulose is the polysaccharide produced from plants. Like methylcellulose, hydroxypropyl cellulose (HPC), carboxymethyl cellulose (CMC), and hydroxypropyl methylcellulose (HPMC) have good film-forming properties. These are usually transparent, tasteless, odorless, flexible, and of moderate strength, water-soluble, resistant to fats and oil, and resistant to oxygen and moisture transmission. The properties of cellulose edible coating affected due to the molecular weight, higher the molecular weight or concentration better are the quality of coating.

Starch based edible films

Starch is a complex form of carbohydrate which is made up of long chain of sugar or glucose molecules. Starch is the storage polysaccharide found in legumes, cereals, and tubers vegetables, like potato, cassava, corn, rice, banana etc. It is a good barrier to oxygen transmission but poor to water vapour. It used for coating vegetables and fruits which shows high respiration rates. Sapper and Chiralt (2018) explained about different starch-based coatings used to preserve the fruits and vegetables along with the factors affecting the coating efficiency.

Gum based edible films

The gums are formulated from polysaccharide. They include exudate gums (gum Arabic), extractive gums (guar and locust bean) and microbial fermentation gums (gellan and Xanthan).

Pectin based edible films

Pectin is common compound found in plant mainly in fruits and vegetables like Guava, Apple etc. Pectin is a polysaccharide made up of galactouronic acids. Pectin is used as coating because of its thickening property and resistant lipids migration and moisture loss. According to Yoosef (2014) Strawberries coated with pectin shown less changes in weight loss, firmness, and also less microbial infection. Menezes and Athmaselvi (2016) reported that pectin-based coatings delay the shelf life of sapotaxfruit by delaying both physical and chemical changes during room temperature.

Chitosan based edible films

Chitosan is derived from chitin; it is an edible polymer, which is made by treating the chitin shells of shrimp and other crustaceans with an alkaline substance, like sodium hydroxide. It is a natural product which is non-toxic and eco-friendly. Chitosan has an antibacterial and antifungal property which helps in food protection. These films are flexible, tough, high durable and very difficult to tear. Chitosan is easily blend with starch and other essential oils; in different combinations it is helpful in increasing shelf life of fruits and vegetables. Chitosan coating regulate gas exchange, reduce transpiration losses thus delays the ripening, modify the fruit internal atmosphere. Rayees *et al.*, (2013) observed that chitosan not only retains firmness but also increases the postharvest quality during cold storage. Xing *et al.*, (2016) suggested that chitosan-based coating with antimicrobial properties have wide range of capacity in preservation of fruits and vegetables

Proteins derived edible coatings

Protein based edible coatings are generally combined with plasticizers or other compounds to increase the physical properties

of that films. Proteins are used as coating material to avoid the moisture loss and to improve the shelf life of the product. Shendurse (2018), explained about the preparation, properties and food application of milk based edible coatings. Certain examples include casein, collagen, gelatin, whey protein, egg white protein, keratin, soy protein, wheat gluten, peanut protein, and corn-zein and cotton seed protein.

Casein derived edible coating

Casein is a major dairy protein, commonly used in the preparation of emulsion. Casein coatings resist oxygen transmission and humidity. These coatings dissolve quickly in water and less stretchy. Chen *et al.*, (2019) reported caseins are desirable biomaterials for the preparation of edible coatings because of the solubility in water, emulsification capability and their high dietary benefits.

Soy protein derived edible coating

These are isolated chitosan that helps to maintain the firmness and reduces the weight loss of the products by providing an excellent barrier against oxygen and poor control of moisture and water vapor. The stability of the soy protein depends on the pH and ionic strength. Kang *et al.*, (2013) reported that soybean protein is suitable for edible coating because of their low permeability to CO₂, O₂ and of its reasonable cost.

Bee wax and paraffin wax

It is a natural wax produced by honey bees of the genus *apis* are widely used after purification. This coating is highly used in mixing with either chitosan or cellulose based coatings. Shahid and Abbasi (2011) evaluated the influence of bee wax coating to maintain physical and biochemical parameters of sweet orange.

Algae derived edible coatings

Alginate is a polysaccharide which is naturally derived from brown algae. These algae based edible coatings helps in increasing fruit quality and extending shelf life of the products. Alginate is excellent barrier to moisture, water vapour and oxygen by which it controls respiration. Huertas *et al.*, (2012) observed delayed physical and chemical parameters of sweet cherry fruit by using different concentrations of sodium alginate (1%, 3% and 5% w/v).

Plasticizers and antimicrobial compounds

Most of the protein and polysaccharide-based coatings are brittle in nature, to solve this problem plasticizers are used to improve flexibility. Glydrol, sucrose, polyethylene glycol, and acetylated monoglyceroids, are used as a plasticizer material for coating of vegetables and fruits.

Essential oils such as lemongrass, cinnamon, clove, oregano, thyme, rosemary, tea tree and bergamot and enzymes such as lysozyme, peroxidase and lacto peroxidase have been used to prepare emulsion coating which gives protection against postharvest pathogenic

spoilage. Natural antioxidants such as tocopherols, tocotrienols, ascorbic acid, carotenoids, citric acid are also used. Saleem (2019) observed the persimmon fruits coated with gum arabic coating prevent spoilage along with extending shelf life.

Herbal coatings

Herbal coatings are generally extracted from aloe gel, neem, tulsi, lemon grass, turmeric and rosemary. Among these aloe gel coating shows best result on mangoes, nectarines, strawberries, apples, cherries, papayas, plums, peaches, tomatoes and table grapes. The gel is colorless, tasteless, odorless, environmentally friendly and transparent in nature. Other than these extracts from ginger, garlic, *Canthiumhorridu*, *Macarangaheimsleyana*, *Vaticamangachapoi*, *Hainaniatrivosperma* have antimicrobial properties. These consists antioxidants, essential minerals and vitamins. Saha (2017) reviewed about plant derived natural gums and their derivatives as edible coatings which are nontoxic, biodegradable, easily available and economical. Ribeiro *et al.*, (2020) summarized the information related to the incorporation of natural extracts in the coatings and films, preparations challenges and opportunities (Table 1 and 2).

Table.1 Ingredients used in the preparation of edible films and coatings

Source	Polysaccharides	Proteins	Lipids
Vegetables	Cellulose and cellulose derivatives, pectin, starch, tara gum	Soy proteins, wheat gluten, corn zein	Vegetable oils, nut oils, seed oils, candeilla, rice bran wax, carnauba wax,
Animals	Chitosan	Gelatin, collagen, milk proteins, egg proteins, myofibrillar proteins	Beeswax, fish oil, shellac

Table.2 Utilization of different coatings for shelf life extension in various fresh fruits
Tropical and Sub-tropical Fruits

Fruit	Coating	Result	Reference
Guava	Guar gum	Guar gum in water resulted in disinfestation. This treatment is effective in extending of shelf life of the fruit and shows disinfestation activity against fruit flies.	Esameldin <i>et al.</i> , (2018)
	Chitosan cassava starch supplemented with <i>Lippiagracilis</i> and Schauer genotype	Formulations containing 2.0% chitosan and 1.0%, 2.0 % or 3.0% <i>Lippiagracilis</i> Schauer genotype, 2.0% cassava starch, were utmost influenceable in decreasing the growth of gram – negative and gram- positive bacteria in vitro and suspending the ripening.	Aquino <i>et al.</i> , (2015)
	Chitosan and alginate along with peel extract of pomegranate	Alginate along with Chitosan and coating combination with pomegranate peel extract (PPE; 1% w/v) increased the quality of guavas during storage at low temperature.	Sneha <i>et al.</i> , (2018)
Banana	Cellulose nanomaterials emulsion as coatings	Cellulose nanofiber-based emulsion varnish had low angle of interaction, maximum spread coefficient onto fruit surfaces and also lowers surface tension than the critical ST of banana peels, and displays good wettability onto surfaces. Also, deferment ethylene	Deng (2017)

		biosynthesis and thereby increasing storage.	
Kinnow mandarin	Chitosan based coatings with Cinnamaldehyde	CI-CH effectively decreased the fruit decay rate, improved the quality of fruits	Gao <i>et al.</i> , (2018)
	Hydroxyl-propyl-methylcellulose coating combination with CaCl ₂ and MgSO ₄	Treating kinnow fruits with combination of CaCl ₂ + MgSO ₄ + HPMC helped to sustain firmness, minimize loss in weight and ethylene production with improved values of acidity and vitamin c contents. Minimum TSS is also observed which advances shelf life of kinnow.	Randhawa <i>et al.</i> , (2018)
	Polysaccharides from opuntia coating in kinnow	2% cactus polysaccharides retain maximum moisture, maximum value for pH of coated citrus while 3.19% cactus polysaccharides coating increases the shelf life and quality of the fruit.	Riaz <i>et al.</i> , (2018)
Persian lime	Soy protein-based coatings including some antimicrobial compounds	Regulates infestation of blue mould, lessens water loss and thus maintains colour.	González-Estrada <i>et al.</i> , (2017)
Orange	Sellac, gelatin and Persian gum as alternate coatings	Coating of 3.5, 4 and 4.5% Persian gum, 5, 6 and 7% gelatin, 9, 10 and 11% shellac gave satisfactorily results.	Khorram <i>et al.</i> , (2017)
Strawberry	Lemon peel essential oil with cassava starch and sodium alginate	They reduced the degradation process. Essential oil of lemon	Rahmawati <i>et al.</i> , (2017)

		peel (0.6%) showed important action as an antimicrobial agent against many bacteria sp like bacillus sp. etc but lemon peel essential oil is helps in inhibition of <i>Botrytis sp</i> and <i>Rhizopus stolonifera</i> like pathogens.	
	Banana starch chitosan, Aloe Vera gel coating	Aloe vera 20%, when used as coating, greatly improves physicochemical properties, such as colour and firmness and weight loss was also reduced.	Pinzon <i>et al.</i> , (2020)
	Three polysaccharide-based coatings (alignate, chitosan and pullulan)	Such polysaccharide coatings also continued total phenolic contents and higher ascorbic acid and significantly decreased fruit decay and respiration in storage along with antioxidant enzyme activity.	Li <i>et al.</i> , (2017)
Blueberry	Sodium alignate, Pectin, Sodium alignate plus pectin	Advances fruit firmness, decreases yeasts growth including aerobic bacteria.	Mannozi <i>et al.</i> , (2017)
Papaya	Aloe Vera gel	In this case aloe vera (1.5%) maintained color & improved physical changes in storage. It proved to be helpful extending the shelf-life of papaya up to 15 days.	Sharmin <i>et al.</i> , (2016)
	Carboxymethylcellulose coating with essential oil	Combination of <i>L. sidoides</i> EO with CMC was proved to be better to extend the shelf life of papayas and also maintained the post-harvest characteristics.	Zillo <i>et al.</i> , (2018)

	Chitosan and propolis extract	Chitosan (1%) in combination with propolisethanolic extract (5%) influenced the postharvest handling of the fruit.	Barrera <i>et al.</i> , (2015)
Mango	Chitosan and Calcium Chloride	Calcium chloride along with chitosan acted as an effective preserving agent and improved of the shelf life of mango in storage.	Shweta <i>et al.</i> , (2014)
	Cassava starch and chitosan coatings	Cassava starch, chitosan, and cassava starch/chitosan (2%) helped in extending the shelf life of the fruit.	Oliveira <i>et al.</i> , (2018)
	Gum Arabic coating with calcium chloride	Guar gum (10%) and also in combination with calcium chloride (3 %) was effective in preserving fruit quality but with low temperature during storage.	Khaliq <i>et al.</i> , (2015)
Ber	Guar gum blended with aloe Vera	Such coating-maintained fruit firmness, colour including acidity under ambient storage.	Arghya M <i>et al.</i> , (2018)
	Chitosan, Guar gum and Gum tragacanth coatings	Extended of shelf life of the fruit.	Nilesh Bhowmick <i>et al.</i> , (2015)
Grapes	Native and octenyl succinic anhydride modified wheat starch coatings	Decreased spoilage of grapes, extends shelf life and sustaining the fruit quality. Starch based coating have capacity to maintain total carotenoids including total phenolic content and as well as the shelf life and quality of the fruit.	Punia <i>et al.</i> , (2019)
	Chitosan nanoparticles coatings	Chitosan nanoparticles as edible coatings can	Castelo <i>et al.</i> , (2018)

		improve the post-harvest quality of grapes to a great extent.	
	Shrimp chitosan and Mentha essential oil	Chitosan in combination with MPEO or MVEO deferred the mold growth and declined the frequency of infections caused by all fungi types like <i>Aspergillus niger</i> , <i>Penicillium expansum</i> etc. in grapes.	Guerra <i>et al.</i> , (2016)
Guava, Mango and Papaya	Chitosan and lemon grass essential oil	Anthraco-nose control during postharvest handling.	Lima <i>et al.</i> , (2018)
Different fruits	Chitosan Mono-Bilayer coatings	Multilayered chitosan-based coatings advance quality characters and regulation the postharvest oxidative stress in many fruits.	Modesti <i>et al.</i> , (2019)

Crop	Coating	Result	Reference
Apple	Aloe Vera, Neem oil and marigold flower extracts as coatings	These coatings maintain the storage quality of the same.	Shweta <i>et al.</i> , (2014)
Peach	Rhubarb extract in sodium alginate-based coating	They advance postharvest traits and extend the shelf life of the fruit.	Xiao-yu <i>et al.</i> , (2019)
	Mango peel and extract of seed kernel	Coating of mango peel, extract of mango kernel and glycerol showed less CO ₂ and ethylene production and less O ₂ consumption.	Cristian <i>et al.</i> , (2018)
Pear	Optimization of edible coating formulations of soy protein isolation, hydroxypropyl methylcellulose and olive oil	Effective combination for less weight loss, improved pH, TSS and TA values.	Nandane <i>et al.</i> , (2016)
(Bartlett)	Sempfresh along with controlled atmosphere and 1-methylcyclopropene	The combination of CA+1-MCP + SF sustained maximum storage quality	Zhi <i>et al.</i> , (2018)

		with improved colour, firmness, and reductions in ethylene production and respiration activity.	
Plum (Santa Rosa)	Lac-based, Semeperfresh and Niprofresh coatings	Lac-based coating retained nearly 55% higher firmness and 21% higher antioxidant activity.	Kumar <i>et al.</i> , (2018)

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