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REVIEW ARTICLE

Edible coatings: A sustainable approach to protect perishable fruits and vegetables

Meghachitra S[1], Sumathi T[2*], Irene Vethamoni P[3], Jeyakumar P[4] & Sharmila Rahale C[5]

[1]Department of Vegetable Science, Horticultural College and Research Institute, Tamil Nadu Agriculture University, Coimbatore 641 003, Tamil Nadu, India

[2]Turmeric Research Center, Tamil Nadu Agriculture University, Bhavanisagar 638 451, Tamil Nadu, India

[3]Department of Horticulture, Horticultural College and Research Institute, Tamil Nadu Agriculture University, Coimbatore 641 003, Tamil Nadu, India

[4]Department of Crop Physiology, Tamil Nadu Agriculture University, Coimbatore 641 003, Tamil Nadu, India

[5]Centre for Agricultural Nanotechnology, Tamil Nadu Agriculture University, Coimbatore 641 003, Tamil Nadu, India

*Correspondence email - sumathi.t@tnau.ac.in

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Abstract

Fruits and vegetables are crucial to a nutritious diet but are highly perishable, posing challenges in maintaining freshness during storage and transportation. This comprehensive review aims to provide insights into the influence of edible coatings on the postharvest preservation of fruits and vegetables. Edible coatings, made from natural polymers such as proteins, polysaccharides and lipids, have gained attention as an effective method to extend shelf life. These coatings form a protective barrier that reduces moisture loss, gas exchange and microbial growth, thereby delaying senescence and preserving quality attributes like firmness, colour, texture and nutritional content. Application methods include dipping, spraying and brushing to ensure uniform coverage. The efficacy of edible coatings depends on factors such as composition, concentration and specific characteristics of the produce. Additionally, incorporating antimicrobial agents like essential oils and plant extracts enhances food safety by inhibiting spoilage microorganisms. Beyond shelf life extension, edible coatings help reduce postharvest losses, improve marketability and decrease reliance on chemical preservatives and synthetic packaging. However, challenges related to formulation optimization, scalability, cost and consumer acceptance must be addressed to enable broader adoption. Overall, edible coatings offer a promising strategy for preserving fruits and vegetables, warranting further research to fully realize their potential in the food industry.

Keywords: antimicrobial; antioxidant; edible coating; nanoemulsion; post-harvest handling; shelf life

Introduction

A wide range of nutrients are found in fruits and vegetables that are essential for maintaining physical well-being. They serve as a storehouse for vitamins, flavouring compounds, bioflavonoids, antioxidants and important minerals (1). Due to the rapid metabolism, moisture loss and disease susceptibility, fruits and vegetables are extremely perishable commodities (2). Transpiration leads to weight loss in fruits and vegetables during postharvest handling and storage, resulting in surface shrinkage and texture changes that reduce shelf life (3). As the global population grows, the demand for fruits and vegetables increase due to their dietary benefits. However, concerns regarding their postharvest quality and shelf life have also intensified. Consequently, the development of various methods to preserve food quality and extend storage attracted the attention of scientists and the food industry (4).

Applying edible coatings is one of the most effective methods for enhancing the storability of fresh produce. Among the many techniques available to prolong product longevity, edible coatings have gained popularity because they are easy to apply and can be modified to possess specific functional properties (5). As edible coatings are eco-friendly, they are used to improve the appearance of food and ensure its safety (6). They enhance the shelf-life and quality of fresh and minimally processed fruits and vegetables by incorporating beneficial substances such as antioxidant and antibacterial agents (7). To modify the structure and enhance the properties of coatings, food-grade additives such as antioxidants, flavouring agents, antimicrobials and pigments can be included, thereby improving overall quality of the produce (8).

One of the most crucial steps in minimizing postharvest losses is delaying biochemical changes such as softening, weight loss, acidity, ethylene generation, colour change and respiration rate (9). Increasing awareness of plastic such as reliance on non-renewable resources, safety concerns and environmental pollution is driving a shift in consumer preferences. The use edible films and coatings as a sustainable alternative is an efficient way to meet this growing demand (10).

Edible coating

When a thin layer of an edible material is applied to the surface of raw or slightly processed fruits and vegetables, it forms an edible coating that serves as a layer of defense (11). Edible coatings are natural, biodegradable, addressing environmental and consumer safety issues (12). Edible coatings use a semi-permeable barrier to reduce moisture, respiration, gas exchange, solute migration and oxidative reaction rates thereby improving shelf life (13).

Properties of edible coatings

It contain antioxidants and antimicrobial attributes; the quality and flavour of vegetables and fruits shouldn't be altered; it must dissolve in a wide range of solvents, including water, alcohol and blends of many solvents; it ought to be less viscous and be affordable; it must transfer volatile taste elements, maintain structural integrity, improve physical handling qualities and be visually pleasing; it should not contain any harmful or allergic ingredients and it must be palatable; it possess strong adhesive qualities (5, 14). The properties of edible coating are shown in Fig. 1.

Types of edible coating

Edible coatings are classified into three types based on composition: polysaccharides, proteins and lipids (Fig. 2).

Polysaccharide based edible coatings: Polysaccharide-based edible coatings serve as oxygen inhibitors due to their well-organized hydrogen-linked network structure; however, they are not effective moisture barriers. These coatings are generally colourless, oil-free and low in calories, which often helps prolong the postharvest storability of fruit by minimizing dehydration and oxidative rancidity (15). The physicochemical characteristics of polysaccharides are influenced by factors such as molecular weight, anomeric configuration, polymerization degree, linkage type, ring size and presence or absence of branching (16). These coatings also slow the respiration rate of fruits and vegetables (17).

In an edible packaging system, polysaccharides contribute properties such as compactness, hardness, adhesiveness, crispiness, viscosity and thickening ability (1). They can be modified through various techniques, including salt addition, heat gelatinization, cross-linking or hydrolysis, solvent changes, pH changes, chemical modification of hydroxyl groups and nanotechnology (18). Due to their ability to protect sensitive compounds in coated foods and release food additives in a controlled manner, polysaccharide-based edible coatings have been widely proposed (19). These edible active coatings serve as excellent carriers and can be incorporated with a variety of useful substances, including flavourings, colourings, antioxidants, antimicrobials and nutritional supplements (20). Edible coatings made of polysaccharides are colourless, low in calories and can be used to extend the shelf-life of foods such as meat, fruits and vegetables (15).

Starch: Starch is a natural polysaccharide used as a dietary hydrocolloid (21). Due to its hydrophilic nature, which makes it water-sensitive and reduces its water vapour barrier capacity, starch cannot be used alone to prepare edible coatings. Therefore, plasticizers and emulsifiers are added to enhance the flexibility and barrier properties (22). Amylose and amylopectin are the two main components of starch, a homopolymer that is semicrystalline, with a crystallinity ranging from 20 % to 40 % (23).

Cellulose: Although cellulose, a structural component of plant cell walls, exhibits excellent film-forming capabilities, its cost limits widespread application (24). Methylcellulose (MC), carboxymethylcellulose (CMC), hydroxypropyl cellulose (HPC) and hydroxypropyl methylcellulose (HPMC) are commercially available cellulose-based edible coatings (25). These coatings provide effective barriers against the transmission of oxygen, oil or moisture when applied to various fruits and vegetables (26).

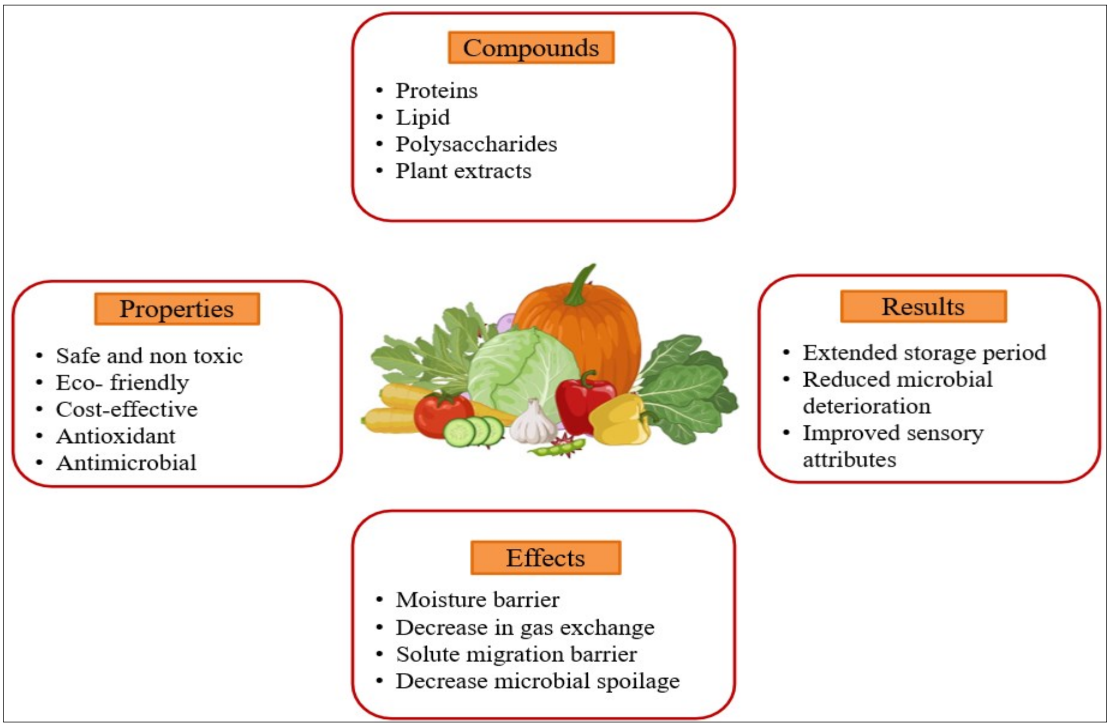

Fig. 1. Properties and functionalities of edible coating.

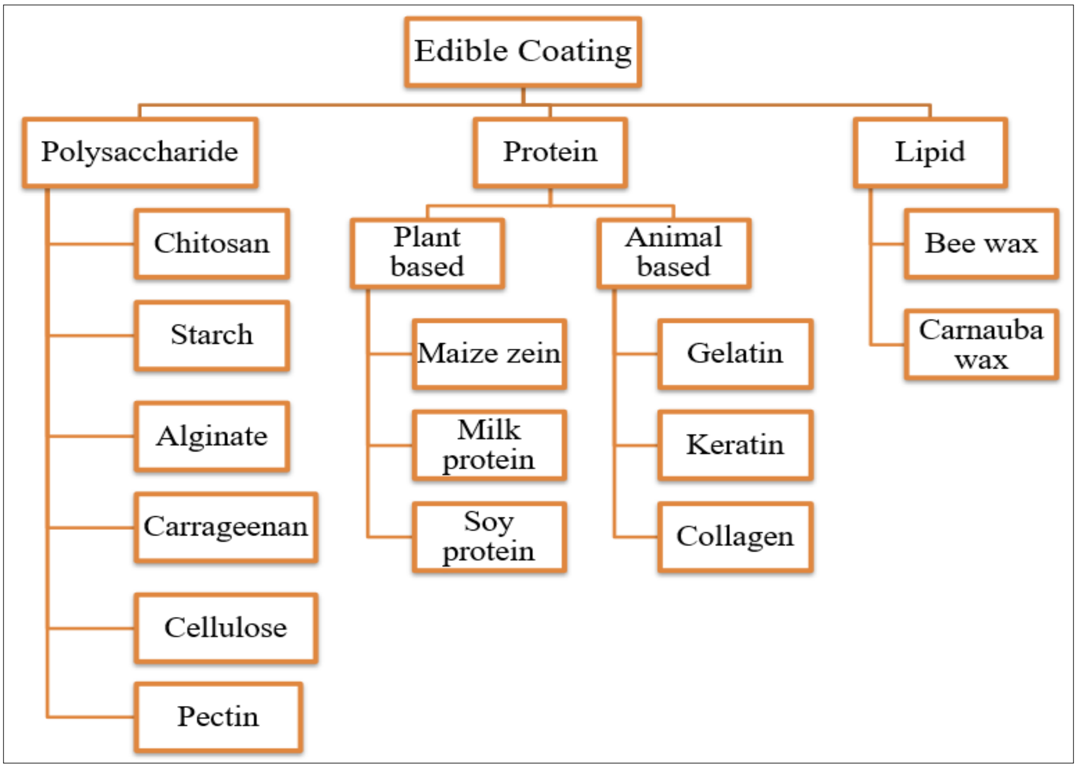

Fig. 2. Classification of edible coating.

Alginate: Alginate, a key polysaccharide extracted from marine brown seaweed (Phaeophyceae), is increasingly used as a texturizing and gelling agent in the food industry (27). It is translucent, water soluble and possesses good film-forming properties. Alginates are highly permeable to water vapour but less permeable to fats and oils (28).

Carrageenan: A variety of red seaweeds, chiefly *Chrondrus crispus*, are the source of carrageenan (21). Carrageenan-based edible coatings and films are renowned for having superior barrier and mechanical qualities (29).

Chitosan: The primary source of chitosan, a cationic biopolymer, is the deacetylation of chitin, a naturally occurring, renewable resource. Chitosan is a biodegradable, non-toxic and commercially available natural polymer that has gained attention in the food industry for its potential use as an edible packaging material. It can form clear films suitable for various packaging purposes. When combined with other natural polymers, chitosan improves the mechanical and functional qualities of the films and coatings. Due to its relatively water-repellent nature, it offers better moisture protection and water resistance. These features make chitosan and its composites highly suitable for creating bio-based active films that support food preservation and shelf life extension (30). Because of its antibacterial and antifungal properties, along with its biocompatibility and biodegradability, chitosan finds extensive use in food, cosmetic and pharmaceutical industries (31). The use of edible coatings made from caseinates or chitosan is promising due to their superior sensory qualities, high nutritional content and sufficient environmental protection of food items (32).

Pectin: Pectin, a natural fibre extracted from plant cell walls, is used to develop edible and biodegradable films with good mechanical strength and flexibility, particularly when blended with high amylase starch and plasticised with glycerol. The films generally have poor moisture resistance, making them more suitable for packaging dry or low-moisture food products (33).

Protein based edible coatings: Proteins used in plant-based coatings include milk proteins, maize zein, soy protein, wheat gluten, as well as animal-based coatings such as gelatin, keratin and collagen (34). Despite their hydrophilic nature and high water vapour permeability, protein-based edible biopolymers offer superior mechanical, optical and gas barrier properties (35). Edible films made of proteins have better mechanical qualities than those made from polysaccharides and fats. However, the application of protein films in food packaging is limited by their relatively low mechanical strength and poor water vapour resistance compared to synthetic polymers (36).

Lipid-based edible coatings: Lipid-based films and coatings, being hydrophobic, are typically thicker and more brittle (37). Lipid formulations that include growth regulators and antifungal agents are applied to fruits and vegetables intended to be preserved for long-term preservation (38). However, a lipid-based coating often results in an oily surface and undesirable organoleptic characteristics, such as lipid rancidity and waxy taste (39). Edible film and coatings based on lipids typically offers an excellent moisture barrier. Edible packaging materials are primarily made from film-forming substances like carbohydrates, proteins or lipids, which provide cohesiveness, while barrier compound ensures the packaging is impermeable. (40). Table 1 outlines edible coatings with different constituents and its attributes.

Plant extracts based edible coatings: Natural polyphenols obtained from plant sources such as leaves, flowers, seeds, roots and fruit peels are increasingly used to improve edible films and coatings for food packaging. These bioactive compounds provide multiple benefits, including antioxidant, antimicrobial, antibrowning, colouring and nutritional functions and are considered a safe substitute for synthetic

Table 1. Edible coatings with different constituents in fruits and vegetables

Nature of coating	Coated fruit/ vegetable	Coating agents	Properties	Reference
Polysaccharide	Melon	Alginate	Fruit firmness enhancement.	(41)
	Peach	Chitosan/chlorogenic acid	Reduction in respiratory rate and weight loss, firmness retention.	(42)
	Strawberry	Chitin, cellulose and chitosan	Decrease weight loss, color changes and microbial development.	(43)
	Litchi	*Aloe vera*	Reduce the browning index and preserve substantially more total anthocyanins. Inhibit cell damage and water loss, which in turn stop the rise in PPO, POD and free radicals as well as the fall in SOD, APX and CAT activity.	(44)
	Grape	Pectin, polyphenylene alcohol and salicylic acid	Improve the qualitative characteristics of the bunches and prevent cell wall deterioration over time.	(45)
	Plum	Rice starch/ι-carrageenan	Keeps the overall quality and extends the lifespan, decrease in weight loss and respiration rate, as well as suppression of endogenous ethylene synthesis.	(46)
Protein	Apple	Whey protein	Storage periods extend by maintaining the total phenolic content and preventing browning and weight loss.	(47)
	Cut carrot	Gelatin, citric acid and glycerin.	Enhance oxygen and moisture barrier that can potentially hinder respiration.	(48)
	Litchi	Zein and glycerol	Better shelf life, higher fruit weight and ascorbic acid content, reduce acidity, a healthy anthocyanin content, a moderate TSS and a physiological weight reduction.	(49)
Lipid	Apple	Carnauba wax	A reduction in loss of weight and a hike in resistance to water vapour.	(50)
	Kiwifruit	Lacquer wax	Boost antioxidant capacity, prevent weight loss, respiration rate and ethylene generation and prolong postharvest life while preserve sensory and qualitative features.	(51)
	Strawberry	Candelilla wax	Decrease in postharvest loss, maintain the targeted quality parameters including pH and total soluble solids and minimize fruit degradation.	(52)

additives. When incorporated into polymer matrices, they enhance various properties like mechanical strength, thermal stability and biological activity, influenced by their interaction with the polymer structure (53). Global food waste, driven by population growth and inadequate post-harvest practices, underscores the need for sustainable packaging and the reuse of nutrient-rich byproducts like seeds and peels. Using plant residues such as pomegranate peels, banana peel flour and pineapple peels in edible coatings significantly improves the physical properties of the films, including strength and elasticity. These coatings also effectively reduce microbial growth, moisture loss and lipid oxidation in fresh-cut produce (54). Plant extracts from fruits and vegetables serve as natural antioxidants in the food and pharmaceutical industries. When added to biopolymer-based edible packaging, these extracts enhance antioxidant activity, reduce UV light penetration and affect the packaging's functional properties through molecular interactions (55).

Essential oil and nanoemulsion based edible coatings: Essential oils (EOs) are plant-based volatile substances with unique antibacterial qualities (56). EOs cannot be used directly in food preparations due to their sensory incompatibility and heat sensitive nature (57). EO-enriched edible chitosan films exhibit effective antimicrobial properties against Escherichia *coli and Staphylococcus aureus* (58). EOs must be administered through appropriate carriers, such as colloidal particles or nanoemulsions (59).

Nanoemulsions are stable colloidal systems composed of two immiscible liquids, with oil droplets ranging from 20 to 200 nm in size, stabilized by surfactants. Their small droplet size enhances stability through Brownian motion and allows for optical transparency due to minimal light scattering. Oil-in-water nanoemulsions used in edible coatings consist of a disperse lipid phase, a continuous aqueous phase and emulsifiers that stabilize the system. The lipid phase can carry non-polar or lipophilic compounds, while the aqueous phase often contains polysaccharides or proteins to form a structural matrix. Emulsifiers such as tweens, spans or lecithin commonly used for food-grade formulations. Nanoemulsions effectively encapsulate lipophilic active substances by reducing droplet size, resulting in increased solubility, stability and potential biological activity (60).

Nanomaterials based edible coatings: Nanotechnology is playing a growing role in the food packaging industry by enabling the creation of nanopackaging with superior barrier, mechanical, thermal, antioxidant and antimicrobial qualities. It is anticipated that such packaging could soon represent 25 % of the total food packaging market. Nanotechnology enhances food safety, prolongs shelf life, reduces food waste and even enables self-repairing packaging materials. Various nanomaterials including nanoparticles, nanocomposites, nanoemulsions and nanofillers like nanostarch, nanocellulose, nanochitosan and nanolipids are being used to improve key packaging functions such as preservation, protection, convenience, marketing and sustainability. Specific nanoparticles like silver, gold, zinc, titanium dioxide and nanoclay help strengthen packaging and protect food from microbial, UV and physical damage. These technologies also support the development of active, smart and intelligent packaging systems that can release preservatives in a controlled manner to extend food freshness (53). Nanotechnology, with its high surface area-to-mass ratio, offers promising solutions for enhancing the shelf-life of fresh produce by enabling stable nanoformulations that deliver active ingredients like antimicrobials, preservatives and nutraceuticals. Advanced synthesis techniques in nanotechnology improve interactions between biopolymers and active agents, resulting in packaging materials with superior barrier properties and reduced microbial load, thus maintaining the postharvest quality of fruits and vegetables (55).

Applying methods of edible coatings

Dipping: This method entails gradually submerging the entire produce surface in the film-forming solution to make sure it is completely moist (61). Previous studies showed that a number of variables, such as duration of immersion, rate of withdrawal, dip-coating cycle count, parameters of coating solution like surface tension, viscosity, density, characteristics of the substrate surface and circumstances for drying, have a substantial impact on the morphology and density of coatings produced by dipping (62). The process of dipping is elucidated in Fig. 3.

Spraying: Spraying technology enables uniform thickness and multi-layer applications like interlayer solutions. It also keeps the coating solution from getting contaminated (63).

Brushing: This technique is specifically employed to manage how a suspension spreads over a material's surface. It is mainly used in the production of films made from polysaccharides and proteins, serving as an alternative to the casting method. The thickness of the applied suspension is regulated by an attached blade. Key factors influencing the behaviour of the suspension droplets include the rate at which they spread and their ability to wet the surface. Additionally, humidity, temperature and the suspension's properties such as density, surface tension and viscosity affect the spreading process (64). Table 2 have demonstrated the application methods of edible coating and its properties.

Bioactive compounds for incorporation into edible coatings

In order to enhance the quality, storage life and safety of vegetables and fruits during storage, active edible coatings that contain various functional compounds can be employed as a preservation technique (76).

Antimicrobial: Edible coatings can be treated with a variety of antibacterial substances. Organic acids (acetic, lactic and benzoic), fatty acid esters, polypeptides (peroxidase, lysozyme), essential oils (lemon grass and cinnamon) and nitrites and sulphates are among the components used (5). Incorporating antimicrobials into edible films and edible coatings helps to enhance shelf-life and safety of food products (77). The incorporation of natural antimicrobial agents (NAMAs) into the film composition activates these biodegradable films in nature (78). Antimicrobial edible coatings may offer improved inhibitory characteristics against spoiling and harmful microbes by maintaining effective levels of the active substances on the product surface (79).

Antioxidants: Fresh fruits and vegetables include antioxidants, which are increasingly being linked to the prevention of degenerative diseases (80). When active substances like antioxidants are added to edible films and coatings, their functional properties can be enhanced, making them useful in food preservation (81). Interest in natural-origin antioxidants, such as plant extracts, essential oils, α-tocopherol, citric acid and ascorbic acid, either individually or in combination, has grown due to the increasing preference for natural ingredients in foods (82).

Texture enhancers: Applying edible coatings with modifiers or texture enhancers can reduce vegetables and fruits softening during storage (82). Polymers like pectic in vegetables and fruits form a network with calcium ions to enhance mechanical strength, delay aging and regulate physiological disorders (83).

Nutraceuticals: Nutraceutical compounds such as minerals (magnesium, zinc and calcium), vitamins (A, D and E), bioactive compounds and essential fatty acids can be added to active coatings to improve the nutritional benefit of vegetables and fruits with low amounts (84). Nutrient concentrations in coatings should be thoroughly investigated to understand their impact on barrier and mechanical qualities (25). Table 3 outlines the

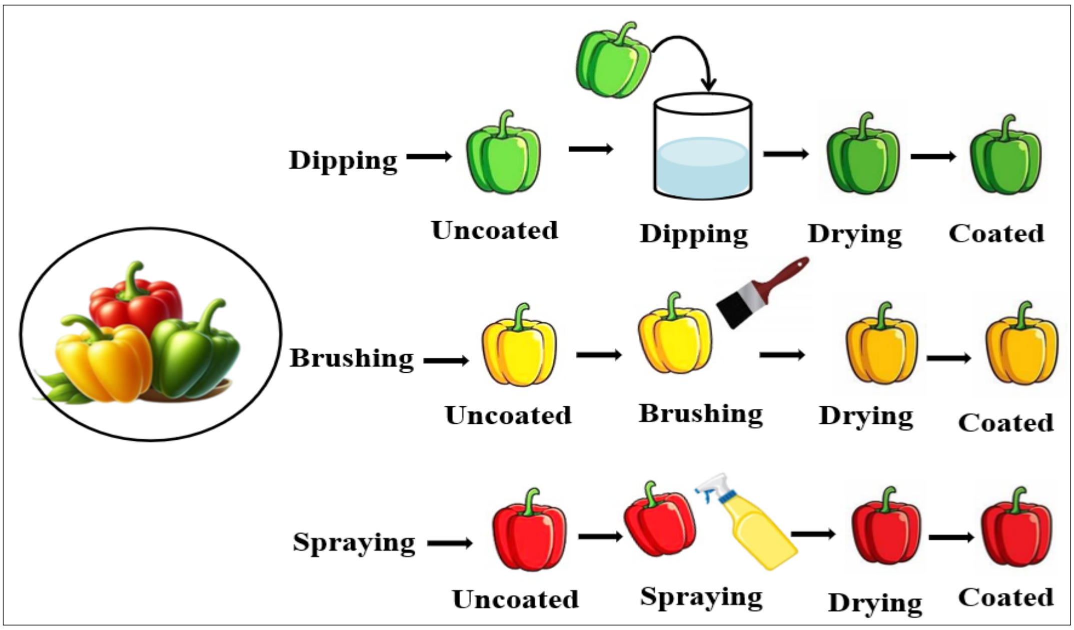

Fig. 3. Different methods of application of edible coating.

Table 2. Application methods of edible coating

Methods of application	Coated fruit/ vegetable	Coating agents	Properties	Reference
Dipping	Bell pepper	Chitosan-pullulan, pomegranate peel extract	Conserve after-harvest quality while preserve the physiochemical and organoleptic properties.	(65)
	Guava	Chitosan	Delays the ripening process and prolongs the quality traits.	(66)
	Tomato	Carboxymethyl cellulose, xanthan gum and pectin	Maintains physiochemical and antioxidants properties.	(67)
Brushing	Cucumber	Chitosan, carnauba wax and oregano essential oil	Decrease microbial load, loss of weight and 15 days lifespan.	(68)
	Zucchini	Arabic gum, whey protein concentrate, thyme essential oil, glycerol and guar gum	Extended storage life.	(69)
Spraying	Okra	Chitosan	Preserves the quality and inhibits microbial and fungal growth.	(70)
	Banana	ι-carrageenan and rice starch	Reduce rate of respiration, ethylene production, weight loss and retain chlorophyll content and fruit firmness.	(71)
	Pineapple	Chitosan, *Aloe vera* gel and eugenol	Improve functional and physico-chemical attributes, maintain quality and longevity by three weeks.	(72)
Layer-by-layer	Pear	Alginate and chitosan	Prolong storage life while preserving color and stiffness.	(73)
	Melon	Alginate/chitosan	Improve fruit firmness and microbiological protection.	(74)
	Mandarin	Chitosan	Best results in terms of organic acid content, antioxidant activity, bioactive substances and visual appeal	(75)

Table 3. Application of active ingredients in edible coating

Active ingredient		Coated fruit/vegetable	Coating agent	Effect	Reference
Antimicrobials	Malic acid	Fresh-cut melon	Alginate	Prolong shelf life and prevent microbiological development.	(85)
	Cinnamon essential oil	Strawberry	Pullulan	Enhance antimicrobial properties.	(86)
	Lemongrass oil	Grape berry	Chitosan	Antimicrobial and antioxidant activity.	(87)
Antioxidant	Ascorbic acid	Strawberry	*Aloe vera*	Maintain postharvest quality and lower the microbial load.	(88)
	Oregano essential oil	Tomato	Pectin	Decreases fungal decay and enhance antioxidant activity.	(89)
	α- tocopherol acetate	Sliced carrot	Alginate	Shelf life extension and reduce loss of weight.	(90)
Antibrowning	Citric acid and ascorbic acid	Fresh-cut apple	Alginate	Reduces weight loss and microbial contamination.	(91)
	Salicylic acid	Banana	Arabic gum	Retain antioxidant activity, reduce weight loss and enhance firmness and index of peel browning.	(92)
Antifungal	Sodium benzoate	Mandarin	Starch	Minimize weight loss and the frequency and intensity of sour rot brought on by *Geotrichum citri-aurantii*	(93)
	Hydrophobic lemongrass oil	Green bell pepper	Chitosan	Maintains the quality characters and controls the anthracnose incidence.	(94)
Nutraceuticals	Calcium gluconate, vitamin E	Strawberries, Raspberries	Chitosan	Increased in nutrient content.	(95)
	Ascorbic acid	Papaya	Alginate	Preserves ascorbic acid.	(96)
Texture enhancer	Calcium chloride	Pineapple	Alginate	Maintains internal liquids.	(97)
	Calcium chloride	Apples	Alginate	Retains firmness during storage.	(98)

properties of active ingredients in edible coating.

Regulations for the application of edible coatings

The composition of edible coatings must adhere to the regulations governing the specific food product in question (11). To ensure the product's safety and quality, each component should be composed of non-toxic, food-grade and may include beneficial additives. Materials used in edible coatings must be approved by the Food and Drug Administration (FDA), generally recognized as safe (GRAS) and used within the established parameters.

According to the European Directive of 1998, substances such as pectins, shellac, bee wax, carnauba wax, candelilla wax, gum arabic and karaya gum may be used in the production of edible coatings. In the same year, additional substances such as polysorbates, fatty acids, lecithin and fatty acid salts were added to this directive. The FDA also permits other ingredients, including castor oil, morpholine, cocoa butter, polydextrose, sucrose fatty acid esters and sorbitan monostearate, for use in protective coatings on fresh fruits and vegetables (5).

To safeguard consumer health from various potentially harmful chemical substances, international regulatory bodies such as the European Food Safety Authority (EFSA) and the FDA have established detailed guidelines. These organizations have developed codes to ensure the safe use of various packaging types and food contact materials (99). According to the Codex Alimentarius, food companies must comply with the regulations of the country in which the food will be consumed. Therefore, food producers must adhere to the laws of both the country of origin and the country of destination when using edible sheets, coatings and other forms of active packaging (100).

Challenges to the use of edible coatings

Coatings can impact customer acceptance due to their sensory effects. The addition of various herbs, spices, antimicrobials and antioxidants may introduce unwanted flavours to the products (4). One major barrier to the industrial use of edible coatings is their high cost, both in terms of sourcing suitable materials and the expense of installing specialized coating machinery (5). Coating thickness may negatively affect a food product's flavour, weight loss and texture. Additionally, the basic ingredients employed in coating preparation cause allergic reactions when ingested (25).

Conclusion

In conclusion, the application of edible coatings holds significant promise in addressing the postharvest losses and extending the shelf life of fruits and vegetables. By forming protective barriers, edible coatings effectively reduce moisture loss, gas exchange and microbial proliferation, thereby preserving the quality of produce during storage and transportation. Moreover, the antimicrobial properties of certain coating formulations contribute to food safety by preventing the growth of microorganisms. However, the widespread adoption of edible coatings in the food sector requires further research and development to optimize formulations, application methods and scalability, while ensuring cost-effectiveness and consumer acceptance. Collaboration among researchers, industry stakeholders and regulatory agencies is essential to overcome challenges such as standardization, labelling and safety assessments.

Despite these challenges, the potential benefits of edible coatings such as reducing postharvest losses, improving marketability and minimizing the reliance on synthetic preservatives and packaging make them a valuable tool in building sustainable food systems. Continued innovation and investment in this technology are crucial to unlocking its full potential and meeting the growing demand for fresh, high-quality produce, while ensuring food safety and security worldwide. The food processing industry is increasingly adopting edible coatings as a sustainable alternative to traditional plastic packaging, aiming to reduce postharvest losses and environmental impact. These coatings help preserve the phytochemical and physicochemical properties of fresh and minimally processed produce, such as antioxidant levels, weight and respiration rate. With advancements in nanotechnology, active edible films now incorporate nanoscale additives, vitamins and bioactive compounds to enhance food quality, microbial resistance and physiological traits such as firmness and freshness. Nanoemulsions have gained significant attention for their ability to encapsulate and release active substances at targeted times, thereby improving both functionality and shelf life. To meet environmental and economic demands, researchers are focusing on eco-friendly, low-cost methods for nanoemulsion preparation, including the use of cellulose-based nanostructures and affordable equipment like low-cost homogenizers, making the process both scalable and sustainable.

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Authors' contributions

MS and ST wrote the original draft and conceptualized the manuscript, revised the original draft, included the tables and figures. MS, ST, IVP, JP and SRC revised and supervised the study. All the authors read and approved the final version of the manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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