Biological Times Volume No. 3 | Issue No. 12 | Pages 12-14

The Role of Edible Coatings in Extending Shelf Life and Ensuring Food Quality

Javeria Shabbir and Sadia Hassan*

Department of Nutrition and Dietetics, The University of Faisalabad, Faisalabad-38000, Pakistan

*Corresponding Author: **sadiahassan88@gmail.com**

ABSTRACT

Edible coatings (ECs) are effective, eco-friendly, biodegradable solutions for maintaining the freshness and quality of perishable foods like meats, fruits, and vegetables. These coatings protect food by preventing deterioration, preserving texture, and maintaining organoleptic properties. Ideal edible coatings (ECs) should possess non-sticky properties, dry quickly, have low viscosity, and be cost-effective. They should also be compatible with versatile application methods such as dipping, spraing, and 3D printing. Acting as a protective barrier, ECs reduce moisture loss, mold growth, and contamination risks, ultimately extending shelf life and reducing food waste, making them vital for food safety, quality, and sustainability.

Keywords: Food security, Edible coating, Food quality, Shelf life, Protective barrier

To cite this article: Shabbir J & S Hassan. The Role of Edible Coatings in Extending Shelf Life and Ensuring Food Quality. Biological Times. 2024 December 3(12): 12-14.

Introduction

Food quality is determined by the organoleptic properties and nutritional value of food, while food safety practices are crucial in reducing potential hazards and pathogens [1]. Food marketing and preserving fresh product quality are essential. Various techniques, including ozone preservation, active packaging, and ultra-high pressure, can be applied to sustain food quality. However, edible coatings (ECs) can help to sustain food quality and offer further advantages including promoting health via nutrient fortification and serving as a carrier for organic preservatives [2].

EC is an environmentally friendly, effective, biodegradable, and biocompatible approach, making it widely used for fresh fruits, meats, and vegetables. Eco-friendly food processing methods are becoming more and more necessary as consumers' demand for natural and healthy meals is increasing. Food shelf life is greatly influenced by the packaging industry, and biodegradable coatings, thus films are quickly emerging as a key component [3]. In addition to achieving packaging requirements, these edible films and coatings also reduce the post-harvest losses of fresh foods. A variety of fresh and less processed foods are preserved by using ECs as shown in table 1. A thin layer of coating material in the form of solution is applied to food surfaces to preserve their texture, and sensory qualities, and prevent rapid degradation [4].

Biopolymers such as proteins, polysaccharides, lipids, and composite materials can be used to form ECs. Essential oils extracted from plants have antimicrobial and antioxidant properties that can be added during the process of edible film coating and enhance its nutritional profile. Meat and dairy products are enriched with essential fatty acids, proteins, vitamins, and energy-rich compounds, which are consumed worldwide [5]. Meat begins to deteriorate after slaughtering, leading to discoloration, off-flavors, and undesirable chemical and structural changes. EC can help to reduce meat deterioration by scavenging free radicals, reducing lipid oxidation, and browning of meat. In the fruit and vegetables processing sector, EC acts as a barrier to prevent gas exchanges and moisture loss, increasing food shelf-life. Coated cheese has improved water vapor permeability, decreased water loss, and improved oxygen barrier qualities [6].

1Research in ECs has increased significantly, with nanotechnology being the major focus. The Food and Drug Administration (FDA) has emphasized hygienic food packaging practices from preparation to delivery to prevent microbial attacks. ECs should have low gaseous permeability, control respiration, and transpiration, be inert, and be highly transparent to maintain food quality standards [4]. The coating material should be non-sticky, low viscous, dried quickly, economical, and have a melting point above 40°C. The appearance and light barrier properties of the coating play a crucial role in attracting consumers. Maintaining the right ratio of adhesion and cohesion molecules is essential for uniform spreading and contraction [7]. The review advances the knowledge of edible coatings and possible techniques for further research.

Materials for Edible Coatings

Various coating ingredients are dissolved with solvents to create the coating solution, including polysaccharides, lipids, proteins, or composites (Fig. 1). To enhance the coating's physiochemical properties, active ingredients like vitamins, essential oils, antimicrobial agents, antioxidants, and plasticizers can be added [8].

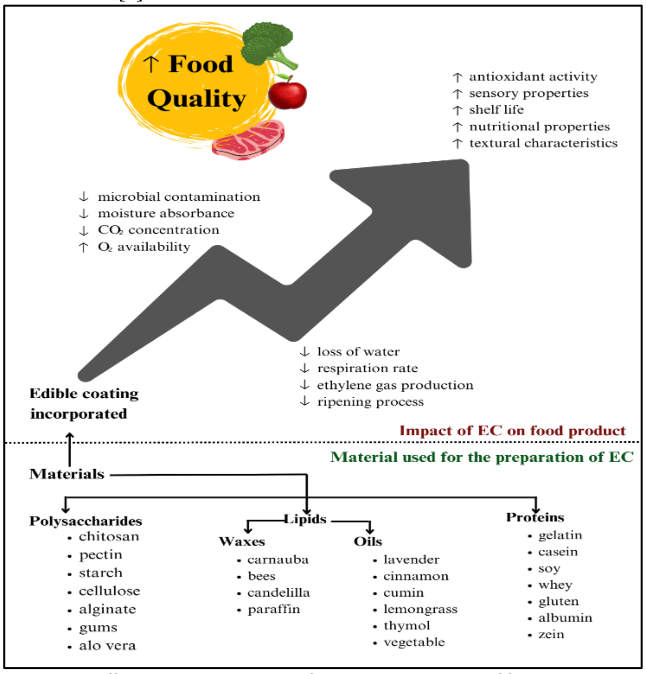

Fig. 1: Different material and impact of edible coating on quality of food products

Methods for Edible Coating

Several techniques are available for applying the coating material on fruits, vegetables, and meats including dipping, spraying, brushing, fluidized bed processing, panning, layer by layer, immerse transmission, 3D food printing, and others (Fig. 2). Some of them are discussed here.

Spraying or Dispersion

The surfaces of fruits and vegetables can be coated uniformly with spray-on coatings that have a predefined composition, thickness, and purpose. With this procedure, simply different ratios of powder (0.1, 0.3, or 0.5g) are dissolved in 99 ml of Milli-Q water to create a xanthan gum solution. To guarantee total solubility, the mixture is magnetically agitated for two hours at room temperature. Moreover, 1% glycerol is added to the solution acting as a plasticizer, while citric acid (2%) is added as an anti-browning agent. The fresh pieces of fruit or vegetables are then covered with the coating. After air drying, the samples are placed in polyethylene bags and kept cold at 5°C for 16 days [9].

Layer by layer

Layer by Layer coating is applied to fruits by dipping them for 30 seconds into alginate and chitosan solution, then allowed to air-dry. The procedure is repeated by dipping the fruit in the appropriate solutions and drying it at one-hour intervals to produce chitosan-alginate-chitosan and chitosan-alginate-chitosan-alginate-chitosan coatings. The fruit is kept for 21 days at 20°C, and its quality attributes are evaluated regularly [2].

Dipping and Brushing

Dipping is an extensively used method for the edible coating of fresh foods, achieving a complete and uniform coating. The process involves immersing the food in a coating solution for a certain period, resulting in a thin layer of edible coating. The contact time depends on the coating solution's parameters, typically lasting between 5 seconds to 3 minutes. The coated sample is allowed to dry undisturbedly, resulting in a uniform coating [10]. The same process is for brushing, except immersing the food in solution, brushing the solution on the food, and letting it dry [11].

Immerse transmission

A new method has been modified to treat food in an air-controlled environment. The lid of the screw jar is sprayed with a liquid seal. The 50 milliliters of distilled water are put into the jar, which is then securely sealed. Post paper coated with air spray is placed over a 2.9L steel cuvette. After removing the air, cuvettes are checked for variations in internal O_2, and CO_2 pressure brought on by gas transmission. Cuvettes are kept at standard air concentration for about an hour, the samples are dried on nets at 20°C and 65°RH using free convection [8].

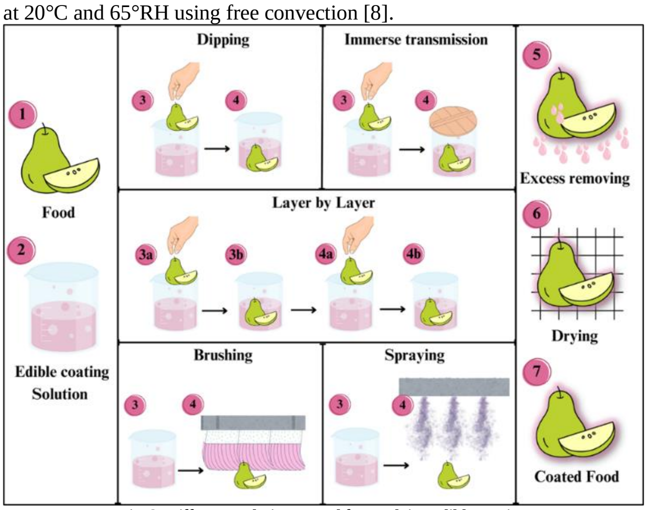

Fig. 2: Different techniques used for applying edible coating

Factors affecting the coating process

The challenges experienced in producing and applying edible coatings on vegetables and fruits are caused by post-harvest quality degradation. A few factors restrict food items from using edible coatings [4, 11]. These are the fundamental factors.

Storage condition

Storing coated food products properly requires considerable effort and time because edible coatings modify the internal atmosphere of the food, affecting its natural ripening process. Additionally, the handling process becomes more complex, as extra precautions are necessary to avoid damage to the coating layer.

Adherence of coating material

For edible coatings to be successful, the coating material must adhere properly to food surfaces. Hydrophilic coatings may not adhere to hydrophobic surfaces, requiring surfactants for improved adhesion and wettability. Improper adhesion may appear unappealing to consumers.

Effectiveness as gas barrier

The effectiveness of this barrier depends on the gas permeability of the coating material. If the coating has limited gas barrier properties, it may fail to adequately regulate ethylene levels, resulting in uneven ripening or reduced quality. Conversely, overly restrictive coatings might trap excessive amounts of carbon dioxide or reduce oxygen to undesirable levels, potentially leading to anaerobic respiration and off-flavors.

Moisture barrier and additives

Low moisture retention in packed food can cause firmness due to water accumulation, while mineral oil coatings reduce moisture loss compared to uncoated food. To avoid off-flavors, it is essential to use the proper plasticizers, additives, and film-forming agents.

Food Safety and Quality

Edible coating significantly improves food quality and safety by providing a protective barrier to food products (Fig. 1). They maintain sensory qualities like texture, appearance, flavor, and aroma, preventing moisture loss, wilting, extending shelf life, reducing mold growth, and improving overall quality [1]. EC prevents browning, discoloration, and surface cracking of food. Additionally, it shields food from outside contaminants like bacteria and viruses, lowering the possibility of microbial growth and foodborne illnesses. Furthermore, EC can postpone food ingredients oxidation, avoiding undesirable flavors and spoiling germs [6].

Legislation

The FDA requires edible coating materials to be Generally Recognized as Safe (GRAS) before they may be utilized commercially. Since the usage of essential oils and natural plant extracts might trigger allergic reactions, appropriate precautions must be taken to assess their toxicity and allergenic nature [7]. The US Environmental Protection Agency and other green packaging programs fund studies on edible coatings that utilize pectin to extend the shelf life and quality of food. Edible coating materials for fresh foods must adhere to regulations and follow Goods Manufacturing Practices (GMP) [1, 4].

Future trends

There is a growing demand for innovative food products, including food-grade nano-emulsions designed to encapsulate and enhance the functionality of specific active substances in food. Edible coatings have gained attention as an alternative solution, driven by consumer preference for safe, chemical-free foods. These coatings are developed using GRAS-certified and approved materials, ensuring safety and compliance. However, commercialization faces challenges, particularly in maintaining desirable sensory and organoleptic properties. Further research is essential to optimize these coatings, extending shelf life while improving their market potential and consumer acceptance [14].

Table 1: Applications for the production of Edible coating

Category	Material	Additional compound	Food	Technique	Parameters Used	Outcomes	Reference
Polysaccharides	Chitosan	Acetic acid	Broccoli	Dipping	The temperature was maintained at 20 °C and 60-70% RH (relative humidity) for 5 days.	Improve the nutritional value, quality, and sensory attributes and minimize the yellowing of broccoli.	[3]
	Xanthan gum	Basil seed gum	Apple	3D food printing	The study used a 1.2 mm nozzle, 1.2 mm layer height, 22 mm/s printing speed, and 100% infill density, by using a rectilinear infill pattern.	Enhances the quality, and sensory characteristics, maintains the nutritional profile, and restricts browning, a great technique to preserve apples for later use.	[12]
	Chitosan	Canola oil	Bell pepper	Spraying	0.5 ml of solution volume was then stored at 12 °C, RH 89 % at a temperature of 20 for 21 days.	The study found that the post-harvest quality of bell pepper nanoparticles, with a shelf life of 5 days, reduced weight loss, and preserved its physicochemical	[9]

						characteristics while being kept in cold storage.	
Protein (polypeptides)	Collagen	Polycaprolactone and bacterial cellulose	Meat	3D food printing	The ink should be heated to 55-56°C in water and then transferred to an airtight container for 10 minutes.	The 3D-printed food achieved the desired pore morphology.	[2]
	Gelatin	Frog skin oil (emulsifier)	Persimmon	Dipping	Fruit quality is monitored at 3-day intervals for nine days using accelerated confection, dipping in coating solution at 20°C for an hour, then allowing the excess layer to drain then stored at 25 °C.	The product slows down fruit damage during storage, reduces weight loss, lowers TSS, and offers increased firmness, pH, and potential for natural coating improvement.	
	Whey protein	Glycerol	Fish	Dipping	MA-WPI films were created by dipping, drying, stirring, and vacuum oven for four hours at 50°C and 12 kPa, and CP treatment at 28°C for 3 minutes.	The coating may improve the steamed fish paste's microbiological safety.	
Lipid	Carnauba wax	Carnauba wax emulsion	Tomatoes (fresh)	Dipping	Food dipped for 3 minutes at 23°C temperature, 80 % RH, and stored for 15 days.	Maintains tomato quality by reducing the rate of spoilage, affects gas permeability, extends shelf life, prevents weight loss, and enhances shine and color.	[12]
	Fatty acid	Lemon essential oil	Cucumber	Immerse transmission	Water vapor and O_2/CO_2 were monitored for an hour at 20°C and 65°F in a liquid seal.	The extension of the shelf life helps to minimize water loss and respiration of fresh cucumbers.	[13]
Composite coating (polysaccharide + lipids)	Duck oil and chitosan	Acetic acid	Meat (chicken)	Dipping	The samples were stirred with 800 rpm magnetic stirring for 2 minutes, then placed for 2 hours at 25 °C, and kept at 4 °C after being packed in polyethylene bags.	The product has lower lipid oxidation and protein breakdown higher viscosity and extends its shelf life by 15 days.	[2]

References

[1] Armghan Khalid M, Niaz B, Saeed F, Afzaal M, Islam F, Hussain M, et al. Edible coatings for enhancing safety and quality attributes of fresh produce: A comprehensive review. International Journal of Food Properties. 2022International Journal of Food Properties;25(1):1817-47.

[2] Andriani V, Handayani NA. Recent technology of edible coating production: A review. Materials Today: Proceedings. 2023;87:200-6.

[3] Fang H, Zhou Q, Yang Q, Zhou X, Cheng S, Wei B, et al. Influence of combined edible coating with chitosan and tea polyphenol on the quality deterioration and health-promoting compounds in harvested broccoli. Food Bioprocess Technology. 2022;15(2):407-20.

[4] Priya K, Thirunavookarasu N, Chidanand D. Recent advances in edible coating of food products and its legislations: A review. Journal of Agriculture Food Research. 2023;12:100623.

[5] Rios DdS, Nakamoto M, Braga A, da Silva E. Food coating using vegetable sources: importance and industrial potential, gaps of knowledge, current application, and future trends, Applied Food Research. 2 (2022) 100073. 2022.

[6] Patil V, Shams R, Dash KK. Techno-functional characteristics, and potential applications of edible coatings: A comprehensive review. Journal of Agriculture Food Research. 2023:100886.

[7] Avramescu SM, Butean C, Popa CV, Ortan A, Moraru I, Temocico G. Edible and functionalized films/coatings—Performances and perspectives. Coatings. 2020;10(7):687.

[8] Nunes C, Silva M, Farinha D, Sales H, Pontes R, Nunes J. Edible coatings and future trends in active food packaging–fruits' and traditional sausages' shelf life increasing. Foods. 2023;12(17):3308.

[9] Matloob A, Ayub H, Mohsin M, Ambreen S, Khan FA, Oranab S, et al. A review on edible coatings and films: Advances, composition, production methods, and safety concerns. ACS omega. 2023;8(32):28932-44.

[10] Suhag R, Kumar N, Petkoska AT, Upadhyay A. Film formation anFood Research Internationald deposition methods of edible coating on food products: A review. Food Research International. 2020;136:109582.

[11] Pham TT, Nguyen LLP, Dam MS, Baranyai L. Application of edible coating in extension of fruit shelf life. AgriEngineering. 2023;5(1):520-36.

[12] Salehi F. Edible coating of fruits and vegetables using natural gums: A review. International Journal of Fruit Science. 2020;20(sup2):S570-S89.

[13] Cruz-Monterrosa RG, Rayas-Amor AA, González-Reza RM, Zambrano-Zaragoza ML, Aguilar-Toalá JE, Liceaga AM. Application of polysaccharide-based edible coatings on fruits and vegetables: Improvement of food quality and bioactivities. Polysaccharides. 2023;4(2):99-115.

[14] Hasan SK, Ferrentino G, Scampicchio M. Nanoemulsion as advanced edible coatings to preserve the quality of fresh-cut fruits and vegetables: a review. International Journal of Food Science Technology. 2020;55(1):1-10.