AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 03, Issue: 04 (April, 2026)
Available online at http://www.agrimagazine.in
©Agri Magazine, ISSN: 3048-8656

Advanced Edible Coatings for Postharvest Preservation of Fruits and Vegetables

*Dr. Prabhu H, Shubhakarini G, Tharhani S, Priyadarshini A, Nibhathna C K, Jai Aswathy A and Srimathi S.
The Gandhigram Rural Institute (DTBU), Gandhigram, Dindigul, India
*Corresponding Author's email: shubhakarinipvi@gmail.com

Edible coatings represent an eco-friendly postharvest technology designed to maintain fruit quality and extend shelf life by forming thin, biodegradable protective layers on produce surfaces. These coatings regulate moisture and gas exchange, mitigate physiological deterioration, and enhance microbial safety. Formulated from natural biopolymers, gums, and plant-based bioactive additives, edible coatings effectively reduce weight loss while preserving firmness, color, and sensory attributes. Despite these benefits, challenges regarding barrier efficiency, sensory impact, production costs, and regulatory frameworks continue to limit large-scale adoption (Alemu et al., 2025). This journal highlights the current materials, physiological benefits, and future research needs for the optimization of edible coating technologies in sustainable agriculture.

Keywords: Edible coatings, Postharvest preservation, Biopolymers, Shelf life extension, Bioactive additives, Sustainable agriculture.

Introduction

Edible coatings are an emerging postharvest technology used to preserve the quality and extend the shelf life of fruits and vegetables by forming a thin, consumable protective layer on their surface. These coatings act as semi-permeable barriers that regulate moisture and gas exchange, thereby slowing physiological and biochemical processes such as respiration, oxidation, and ripening (Olivas et al., 2008). Being biodegradable, non-toxic, and environmentally friendly, edible coatings serve as sustainable alternatives to synthetic packaging materials. In addition to reducing postharvest losses, they help maintain nutritional value and sensory attributes—including texture, appearance, and freshness. Furthermore, the incorporation of antioxidant and antimicrobial properties enhances food safety and storage stability, making them a highly promising solution for modern postharvest management (Salehi, 2020).

Materials and Formulation Components

Biopolymers and Hydrocolloids

Natural biopolymers and hydrocolloids constitute the primary matrix of edible coatings due to their excellent film-forming ability and sustainability. These materials function as semi-permeable barriers that effectively regulate gas exchange, reduce water loss, control respiration rates, and delay ripening processes (Parreidt et al., 2018).

Natural Gums

Water-soluble natural gums are widely utilized to replace synthetic packaging materials. Commonly used gums include:

- **Chitosan:** Considered highly effective due to its strong antimicrobial, antifungal, and antibacterial properties, as well as its ability to form strong, flexible films (Shiekh et al., 2012).

● **Gum Arabic:** Extensively used for its ability to delay softening, reduce weight loss, and maintain firmness, resulting in improved fruit marketability (Al-Juhaimi et al., 2012).
● **Other Hydrocolloids:** Alginate, xanthan, guar, gellan, and basil seed gums also play significant roles in maintaining fruit quality (Parreidt et al., 2018).

Plasticizers and Solvent Systems

To prevent the brittleness and cracking of the coating, plasticizers such as glycerol are commonly incorporated. The inclusion of plasticizers significantly reduces moisture loss in coated fruits during storage. Water is typically used as the primary solvent system, facilitating the dissolution of biopolymers and ensuring uniform application over the fruit surface (Kaur et al., 2023).

Bioactive Additives

Edible coatings may be enriched with plant-derived bioactive compounds to enhance preservation efficiency. These natural additives—including phenolic acids, carotenoids, anthocyanins, and flavonoids sourced from herbs, spices, and agricultural by-products improve the antioxidant capacity and antimicrobial activity of the films, effectively inhibiting pathogenic microorganisms and slowing food deterioration (Bajaj et al., 2023; Kaur et al., 2023).

Physiological Effects and Postharvest Benefits

The application of plant-based edible coatings results in several measurable improvements in the postharvest quality of fresh horticultural produce:

● **Shelf Life Extension:** Edible films form protective layers that regulate respiration, prevent enzymatic browning, and protect against microbial contamination, significantly extending shelf life in perishable fruits such as mango (Tavassoli-Kafrani et al., 2020).
● **Weight Loss and Firmness:** By forming semi-permeable barriers that limit moisture transfer, coatings reduce weight loss. Fruits retain greater firmness due to the reduced enzymatic degradation of cell wall components, which delays physiological deterioration (Khatodiya & Malik, 2022).
● **Color and Appearance:** Coatings help maintain natural fruit color by minimizing enzymatic browning and delaying pigment degradation. Polysaccharide and chitosan-based coatings are particularly effective in preserving surface gloss and visual quality (Rattanapanone et al., 2007).
● **Microbial Quality:** Chitosan-based films and coatings infused with natural bio-fungicides significantly reduce microbial loads on fresh produce, improving overall microbiological safety (Moreira et al., 2008).

Challenges and Commercial Limitations

Although edible coatings offer a sustainable preservation method, several limitations restrict their widespread commercial application (Gidado et al., 2025):

● **Barrier Efficiency:** Hydrophilic biopolymers generally possess poor water vapor barrier properties, reducing their ability to control moisture loss in varying environmental conditions.
● **Sensory Alterations:** Edible coatings may alter sensory attributes such as taste, aroma, and color, particularly when bioactive compounds or essential oils are used at higher concentrations, which can reduce consumer acceptability (Duguma, 2021).
● **Industrial and Regulatory Hurdles:** High production costs, a lack of standardized application guidelines, and regulatory challenges restrict commercial adoption. While nanotechnology-based coatings offer potential solutions, their application remains largely limited to the laboratory scale due to difficulties in scaling up and regulatory approval (Wang et al., 2025).

Conclusion

Edible coatings represent a highly promising, sustainable, and eco-friendly postharvest technology for preserving the quality of fresh produce. Formulated from natural materials and enriched with plant-derived bioactive compounds, these coatings effectively regulate

moisture, enhance microbial safety, and maintain the sensory and nutritional quality of fruits. However, challenges related to moisture barrier properties, sensory changes, and high production costs must be addressed. Future research should focus on optimizing formulations, developing cost-effective processing technologies, and establishing clear regulatory guidelines to successfully support the industrial application of edible coatings in postharvest fruit preservation.

References

1. Alemu, T. T., Intipunya, P., & Gebeyo, B. A. (2025). A Comprehensive Review of Edible Coatings for Postharvest Management of Fruits and Vegetables: Enhancing Food and Nutrition Security. Discover Agriculture, 3, 190.
2. Al-Juhaimi, F., Ghafoor, K., & Babiker, E. E. (2012). Effect of Gum Arabic Edible Coating on Weight Loss, Firmness and Sensory Characteristics of Cucumber (Cucumis sativus L.) Fruit During Storage. Journal of Food Processing and Preservation, 36(5), 396–402.
3. Bajaj, K., Adhikary, T., Gill, P. P. S., & Kumar, A. K. (2023). Edible coatings enriched with plant-based extracts preserve postharvest quality of fruits: A review. Progress in Organic Coatings, 183, 107669.
4. Duguma, H. T. (2021). Potential applications and limitations of edible coatings for maintaining tomato quality and shelf life. International Journal of Food Science & Technology, 57(3),1353–1366.
5. Gidado, M. J., Nagoor Gunny, A. A., Gopinath, S. C. B., Devi, M., Jayavalli, R., & Ilyas, R. A. (2025).Challenges in selecting edible coating materials for fruit postharvest preservation and recent advances in edible coating techniques: A review. Journal of Food Science and Technology, 62(4), 612–622.
6. Kaur, J., Singh, J., Rasane, P., Gupta, P., Kaur, S., Sharma, N., & Sowdhanya, D. (2023). Natural additives as active components in edible films and coatings. Food Bioscience, 52, 102689.
7. Khatodiya, N., & Malik, M. (2022). Review: Effects of Edible Coating on Fresh-Cut Fruits. Journal of Pharmacognosy and Phytochemistry, 11(1), 225–231.
8. Moreira, M. R., Ponce, A., Del Valle, C. E., & Roura, S. I. (2008). Edible Coatings on Fresh Squash Slices: Effect of Film Drying Temperature on the Nutritional and Microbiological Quality. Journal of Food Processing and Preservation, 32(1), 108–121.
9. Olivas, G. I., Dávila-Aviña, J. E., Salas-Salazar, N. A., & Molina, F. J. (2008). Use of edible coatings to preserve the quality of fruits and vegetables during storage. Stewart Postharvest Review, 4,1–9.
10. Parreidt, T. S., Müller, K., & Schmid, M. (2018). Alginate-Based Edible Films and Coatings for Food Packaging Applications. Foods, 7(10), 170.
11. Rattanapanone, N., Plotto, A., & Baldwin, E. (2007). Effect of Edible Coatings and Other Surface Treatments on Pericarp Color of Thai Lychee Cultivars. Proceedings of the Florida StateHorticultural Society, 120, 222–227.
12. Salehi, F. (2020). Edible Coating of Fruits and Vegetables Using Natural Gums: A Review. International Journal of Fruit Science, 20(suppl. 2), S570–S589.
13. Shiekh, R. A., Malik, M. A., Al-Thabaiti, S. A., & Shiekh, M. A. (2012). Chitosan as a Novel Edible Coating for Fresh Fruits.
14. Tavassoli-Kafrani, E., Gamage, M. V., Dumée, L. F., Kong, L., & Zhao, S. (2020). Edible Films and Coatings for Shelf Life Extension of Mango: A Review. Critical Reviews in Food Science and Nutrition.
15. Wang, X., Wang, Y., Zhu, H., Chen, S., Xue, J., Xiao, Z., & Luo, Y. (2025). Emerging strategies for food preservation: Recent advances and challenges in nanotechnology for edible coatings. Agricultural Products Processing and Storage, 1, 13.