Article Id
AL04314

EDIBLE PACKAGING: A SUSTAINABLE FOOD FUTURE

Raju C. A.

Email
rajuca80@gmail.com

Department of Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka- 560065, India

Food packaging plays a critical role in the food industry's ultimate preparation process and is an essential link in the food supply chain. Its essential function in society is to safeguard food from deterioration and damage, maintain safety and hygienic conditions, and aggressively minimize food waste. Nevertheless, spoiling causes more than 30% of food to be lost, adding to the world's solid waste problem, which is expected to reach 2.2 billion tons yearly by 2025. Conventional packaging exacerbates environmental problems by causing pollution and dependency on petroleum reserves. It is frequently non-biodegradable and made of non-renewable resources like plastic. The effects on the environment highlight the necessity of sustainable food packaging alternatives in order to solve waste and pollution issues in the sector.

Growing customer expectations for natural, premium, and sustainable goods have resulted in a change in emphasis toward the development of eco-friendly packaging amid environmental concerns. Reducing environmental effect can be achieved by using components including proteins, lipids, chitosan, starches, and cellulose derivatives in edible packaging. With a predicted CAGR of 7.64% from 2021 to 2027, the worldwide market, estimated at USD 2.06 billion in 2020, reflects this move toward environmental consciousness. The increase in popularity of edible films and coatings as environmentally friendly substitutes for traditional plastic packaging is the reason for the expansion. Benefits of this packaging include biocompatibility, simple decomposition, non-toxicity, and gas and moisture barrier qualities. The potential of edible packaging to lower waste in landfills, lower pollution, and help mitigate climate change is substantial, despite obstacles including limited resistance to gases and liquids and the requirement for industrial-scale manufacture. The food industry's attitude to sustainability might undergo a radical change as research on edible packaging advances.

Edible Packaging

Foods have been protected and moisture loss prevented for centuries by the use of edible coatings, which have their origins in China in the 12th century and subsequently in England. As these coatings developed throughout time, they were used in the 20th century to make chocolate and other sweet coatings for confections, improve the sheen on fruits and vegetables, and stop water loss. The historical relevance of these items emphasizes their ongoing contribution to the preservation and enhancement of different food products' attractiveness.

When it comes to active food packaging, edible packaging is unique since it is biodegradable and sustainable while yet providing better food-quality optimization than conventional packaging techniques. Food quality preservation, shelf life extension, waste reduction, and improved cost-effectiveness of packaging materials are among its uses. Sophisticated and adaptable, edible films are made of different materials and may be used as vehicles for active ingredients such as antimicrobials and antioxidants. They represent a significant advancement in the field of food science. This subject has a lot of promise, as seen by the rise in research activity over the last 10 years.

A thin, continuous layer of edible substance created on, deposited on, or between foods or food components is known as an edible film or coating. In order to improve the shelf life and quality of food products, edible packaging is available in a variety of forms, such as composite edible packaging, smart/intelligent and active packaging, nanopackaging, and nanoformulations. Edible packaging is an essential component that protects food from mechanical, chemical, physical, and microbiological hazards. In order to maintain the best possible preservation and food quality, it serves as a protective barrier, blocking oxidation, water penetration, and unwanted enzyme activation. Edible ingredients, mostly natural polymers that are safe for human consumption, are the source of the materials utilized in edible packaging. These substances may be processed to create films and coatings of varying densities. Films are used for wraps, pouches, bags, capsules, and casings, whilst coatings become an integral component of the food product and are not intended for removal. A food product's individual composition, processing techniques, and material choice all influence the edible packaging components used. It's critical that the meal be compatible with the senses. Though progress has been made, questions remain about how to safely and effectively scale up edible food packaging on an industrial scale.

Forms of Edible Packaging

Edible coating: Food surfaces are directly coated with edible materials in the form of liquid suspension, emulsion, or powder. A diffusion-based adhesion procedure is used in the application to guarantee a smooth transition between the coating solution and the food product's surface. These coatings are applied using a variety of techniques, including as dipping, spraying, brushing, fluidized bed processing, and the panning technique. Foods are submerged in the coating solution while using the dipping technique, whereas the spraying technique applies the coating uniformly. Food products are coated with a stream of air in fluidized bed processing, whereas brushing allows for more accurate coating application. Food products are tumbled with the coating solution in a rotating drum using the panning process. These application methods highlight the adaptability of edible coatings in the food business by improving food quality, shelf life, and aesthetic appeal.

Edible films: Typically, edible ingredients are dissolved in solvent combinations, water, or alcohol to create edible films. Plasticizers are added to the matrix material to improve its mechanical qualities, which increase its durability and flexibility. Additional ingredients, such colors, flavorings, and antimicrobial agents, are added in accordance with the needs of the edible material for the purpose for which it is designed. The surface characteristics of the intended food product, such as wettability, contact angle, and surface tension, have a significant impact on the choice of edible packaging solution and application technique.

The ways that coatings and edible films are applied differ from one another. Using techniques like lamination or multilayering, edible films are created as solid sheets that are then applied to food products. Edible coatings, on the other hand, are applied directly to the surface of food in liquid form. To maximize the use of edible packaging in the food sector and make sure that the technique used is in line with the unique requirements and features of the food product being packaged, it is imperative to comprehend these subtle variances.

Materials for Edible Packaging

Edible packaging utilizes a variety of materials derived from natural sources, providing sustainable alternatives to traditional packaging. The key materials used for edible packaging include:

- **Protein:** Keratin, egg white protein, rice bran protein, soy protein, collagen, cottonseed protein, peanut protein, corn zein, wheat gluten, fish myofibrillar protein, sorghum protein, gelatine, and casein.
- **Polysaccharides:** Pectin, chitosan, gum, alginate, carrageenan, xanthan gum, modified cellulose (CMC, MC, HPC, HPMC), modified starch, and modified starch modified cellulose.
- **Lipids:** Acetoglycerides, shellac, terpene, and waxes such as candelilla, rice bran, paraffin, carnauba, and beeswax.
- **Composite:** Emulsion and bi-layer composite films.
- **Plasticizers:** Water, polyethylene glycol, glycerine, sorbitol, sugar, and propylene glycol.
- Functional additions include tastes, colours, nutrients, antioxidants, antimicrobials, and nutraceuticals.
- **Additional ingredients:** lipid emulsions (fatty acids, edible waxes), emulsifiers (lecithin, tweens, spans).

These substances are picked because they can produce films or coatings that are appropriate for a variety of food items, are safe to eat, and biodegrade. The choice is frequently based on the intended properties of the edible packaging as well as the particular specifications of the packaged food.

Characteristics of Edible Packaging

Many elements are important to achieve the desired qualities in films, coatings, and edible packaging. Physical, chemical, mechanical, thermal, barrier, and biological properties are all included in this. Moisture/gas barrier, rheological, adhesive characteristics, transparency, solubility, mechanical strength, color, and antibacterial qualities are some of the important attributes. Polymer type and crystallinity, formulation parameters, solvent selection, and additive concentrations are a few examples of influencing variables. The quality of the packaging system is also greatly impacted by the surface qualities and attributes of the food item, as well as the deposition techniques used. The efficiency and applicability of edible coatings and films in preserving and improving food items are determined by the complex interactions among these variables.

Advantages of Edible Packaging

Edible packaging offers a range of benefits, making it a compelling choice in the pursuit of sustainable and innovative packaging solutions. The key attributes that contribute to its increasing popularity in the food industry include:

- Environmentally friendly, recyclable, and entirely eaten or biodegradable.
- Boosts the qualities of organoleptic features, such as colour and sweetness.
- Through supplementation, nutritional qualities are improved.
- Delay the climacteric fruits' ripening period.
- It is feasible to package fruits like strawberries individually.
- Movies can function as carriers of antioxidant or antimicrobial compounds.
- One use for film is the microencapsulation of flavouring compounds.
- Food waste may be minimized by using edible packaging to increase the shelf life of food items and decrease the chance of deterioration.
- Food-grade films and coatings offer a safeguard against environmental elements including moisture and oxidation, which can help maintain and improve the quality of food items.

Limitations of Edible Packaging

- The cost of the new wraps is higher than that of synthetic packaging. The developer thinks that the benefits to the ecology and nutrition, however, will outweigh the higher price.
- During food distribution and storage, they would be utilized to wrap food items within an additional synthetic packaging.
- Deficient mechanical characteristics.

Applications of Edible Packaging

Fresh-cut fruits and vegetables, meat, cereals, nuts, cheese, baked goods, and confections are among the food categories for which edible packaging appears to be a feasible option. Effective uses demonstrate how versatile it is, with the type of food, how long it will be stored, and other factors influencing the edible packaging option. With its flexible and ecological packaging solution, this invention meets a range of needs in the food sector.

Regulations

Food-grade packaging, which comes in the same categories as packaging materials and food contact substances, is an important part of food products. Following food laws is essential, since they demand the use of FDA-approved or generally recognized as safe (GRAS) substances. When using edible packaging materials and additives, adherence to Good Manufacturing Practices (GMP) is crucial. Common ingredients include proteins from wheat, peanuts, soy, fish, eggs, and milk. As a result, allergy labeling regulations, such as the Food allergy Labelling and Consumer Protection Act of 2004, must be followed.

Conclusion

In conclusion, the food sector has made great progress toward sustainable and consumer-friendly alternatives with the rise in interest in and innovation around edible packaging. Promising benefits associated with the use of biopolymers include biodegradability, ease of processing, and compatibility with human health. Nutraceuticals and plant extracts are examples of additives that not only improve the functional performance of packaging but may also offer possible health advantages to customers. Subsequent research endeavours have to concentrate on honing coating technologies, enhancing bio-based material compositions, and tackling issues associated with the potential hazards of human ingestion. As edible packaging continues to develop, there is potential for intelligent design solutions where active, intelligent, and sustainable characteristics come together to provide improved product quality and safety in the changing food packaging market.

References

Cerqueira, M.A.P.R., Pereira, R.N.C., da Silva Ramos, O.L., Teixeira, J.A.C. and Vicente, A.A. eds. (2017). Edible food packaging: materials and processing technologies.

Chhikara, S. and Kumar, D. (2022). Edible coating and edible film as food packaging material: A review. *Journal of Packaging Technology and Research*, 6(1), 1-10.

Kumar, A., Hasan, M., Mangaraj, S., Pravitha, M., Verma, D.K. and Srivastav, P.P. (2022). Trends in edible packaging films and its prospective future in food: a review. *Applied Food Research*, 2(1), 100118.

Kumar, N., Pratibha, Prasad, J., Yadav, A., Upadhyay, A., Neeraj, Shukla, S., Petkoska, A.T., Heena, Suri, S. and Gniewosz, M. (2023). Recent Trends in Edible Packaging for

Food Applications - Perspective for the Future. *Food Engineering Reviews*, 15(4), 718-747.

Petkoska, A.T., Daniloski, D., D'Cunha, N.M., Naumovski, N. and Broach, A.T. (2021). Edible packaging: Sustainable solutions and novel trends in food packaging. *Food Research International*, 140, 109981.