Chapter

Edible Packaging of Food Items and Beverages

Amitabh Aharwar and Mahendra Kumar Sahu

Abstract

Microbes, enzymes, oxidation, and other environmental variables during handling and storage make food ingredients extremely vulnerable to spoiling. Food must be protected from a variety of elements by being properly packaged. Paper, plastic, etc., are only a few of the packaging materials employed for food packaging; however, these constituents are neither environmentally friendly nor sustainable. Disposing of food waste and packaging has become an issue at recent times. Edible packaging uses sustainable materials that are completely biodegradable and safe to eat together with the product. Because of its better qualities, edible packaging may be a viable substitute for traditional packaging. Food-grade films, coatings, or containers are constructed by lipids, carbohydrates, proteins, composites, and other materials. In addition to preserving food safety and cleanliness and protecting food and food items from deterioration, edible packaging actively lowers food waste. A novel tactic to raise the quality of food is edible packaging. To increase the package's beneficial function for packaged food, additives are applied during its manufacturing. Edible coatings and films are recent sustainable types of techniques for covering food-related items. This chapter covers edible packaging materials, edible film and coating fabrication techniques, beverage-related packaging and benefits, and drawbacks of edible packaging.

Keywords: edible films, biopolymer, edible packaging materials, edible coatings, food packaging, beverage

1. Introduction

Enclosing and safeguarding goods for use, storage, and distribution is known as packaging. The market offers a variety of packaging materials, including paper, plastic, cardboard, and others [1]. According to market and research reports (2020–2025), the annual use of materials derived from plastic has grown by around 230 million tons so far. Furthermore, synthetic and plastic-based materials are not biodegradable and have numerous negative effects on the environment [2]. Because of easy to shape, less weight, and less cost, plastics are widely used in food packaging, but they are non-degradable and have a negative impact on environment [3]. Some materials, such as paper and paperboard, have relatively high recycling rates (over 20% in conventional packaging), whereas other materials, like various plastics, typically have less than 20%; that is, low recycling rates pose an environmental burden. Packaging materials that do not biodegrade are unsustainable and pollute the environment [4].

Films, coatings, or containers made of food ingredients that are safe to consume with the product [5]. By forming a barrier against water and oxidation and regulating enzymatic activation, edible packaging helps shield food items from chemical, microbiological, mechanical, and physical harm. Qualities of edible constituents and food products are enhanced by the use of active ingredients such as plant extracts, nanomaterials, cross-linkers, in edible packaging [2]. A variety of additives, including flavorings, colorings, and sweeteners, are present in packaging material. Edible packaging is structured by lipid, carbohydrate, protein, composite, etc. [1, 5]. To improve the food preservation, increase lifespan, and guarantee microbiological safety, bioactive substances are added in active packaging. Film strength, stability, and controlled release are enhanced *via* nanocomposite reinforcement [6]. But in intelligent packaging, some sensors are embedded in the packages such as anthocyanin and curcumin. Some are used as pH indicators in edible packaging of meat products and seafood [7].

Food packaging by edible packages actively reduces food waste while maintaining safety and cleanliness and shielding food and food items from deterioration. According to estimates, about 30% of food produced ends up in landfills as a result of spoiling during harvesting and transportation [8]. Food in edible packaging retains its moisture content, gas, and fragrance [9]. Food packaging materials should be environmentally friendly, naturally organic, better in quality and positive for health. The food business faces a difficulty in creating environmentally friendly packaging while reducing pollutants [5]. Biopolymers-based edible packaging is more famous at present [10]. Films, coatings, sheets, and pouches are all examples of edible packaging. Thickness is a crucial physical characteristic in edible film formation and less than 0.3 mm is thought to be the ideal thickness [11].

Vegetable and fruit postharvesting preservation is essential to minimize the respiration rates, regulate moisture loss, decrease physiological changes, and stop microbial infections [12]. The controlled interchange of gases such as O_2, CO_2, and ethylene required in the respiration of food products is made possible by edible packaging [13]. The organoleptic qualities of packed meals can also be improved by edible packaging, which can customize the surface qualities such as hydrophobicity, hydrophilicity, flavors, and colors [4]. Although it may appear to be a recent development, edible packaging is actually a very old technique that has been used for generations to preserve food. In order to preserve them and prevent water loss during storage and transportation, wax was originally applied to lemons and oranges in China during the twelfth century [14]. Commercial waxing and lipid coatings were used on fruits and vegetables in the 1930s to promote natural respiration and avoid dehydration while in transit [3]. Using edible packaging has certain drawbacks, such as the new edible wrappers being more expensive than synthetic packaging. After the packing, an additional container is required. Sometimes, edible packaging is not suited for flavor [1]. In this chapter, edible packaging materials, edible packaging preparation processes and advantage and limitations related to edible packaging are discussed.

2. Edible packaging materials

Natural polymers are the packaging materials that are edible and pose no health risks to humans when consumed directly. Proteins, lipids, polysaccharides, and composites are used in packaging (**Table 1**). Edible materials can be combined with other ingredients or may be used alone in a variety of food technology applications (**Table 2**) [29]. By employing nanotechnological methods and incorporating bioactive

Polysaccharides	Lipids	Additives
• *Marine*: agar, alginate, carrageenan • *Microbial*: xanthan gum, pullulan • *Plant*: cellulose, hemicellulose, starch, pectin • *Animal*: chitin, chitosan	• *Plant*: oils, waxes, fatty acids, cutin, resin • *Animal*: animal fats, bee wax, resin	• *Plasticizer*: polyols, mono & oligosaccharides, lipid and its derivatives • *Emulsifier*: natural lecithins, sodium lauryl sulfate, glycerol monopalmitate etc. • *Antimicrobial*: chemical agents, natural extracts and probiotics • *Plant extract*: extracts of plant's seeds, roots, bark, buds, flowers, and leaves
Protein	**Composite**	
• *Plant*: wheat gluten, corn zein, soya protein, pea protein • *Animal*: collagen, gelatin, fish protein • *Milk*: casein, whey protein	• Multicomponent • Lipid and protein mixture • Carbohydrates and protein mixture • Carbohydrates and lipid mixture • Synthetic and natural polymers mixture	

Table 1.
Edible packaging materials.

Food items	Edible materials	Effect	Reference
Blueberries and raspberries	Carrageenan and green tea extract	Antiviral action against hepatitis A virus and murine norovirus	[15]
Banana	Aloe gel, lemon peel extract, and glycerol	Decrease in the prevalence of ascorbic acid, fruit deterioration, reduction in weight, and anthracnose illness	[16]
Apple	Sodium alginate, calcium chloride, and glycerol	Improved antioxidant activity during storage, decreased chill injury, respiration rate, and physiological loss of weight.	[17]
Lemon	Coconut oil and beeswax	Color retention and increased shelf life	[18]
Strawberries	Banana starch, chitosan, and *Aloe vera* gel and glycerol	Decrease in PLW, stiffness, and enhancement of general qualitative characteristics	[19]
Lime fruit	Pectin-based coating	During storage, there was a progressive rise in shriveling or wilting and a loss of green color; these changes were increased by higher temperatures.	[20]
Strawberries	Chitosan/MFC-based composite films/coating	An important improvement in the mechanical, barrier, and colloidal stability qualities necessary for environmentally friendly food packing applications was obtained.	[21]
Dry goods and grains	Carboxymethyl cellulose (CMC), starch-cellulose nanocomposites	Forming a barrier of fat and gas in beans, breakfast cereals, and nuts.	[22]

Food items	Edible materials	Effect	Reference
Apple slices	Locust bean gum, cladode polyphenols, and *Opuntia* mucilage to create an active edible film	Apple slices' freshness is well preserved, and their shelf life is increased while they are being stored.	[23]
Fruits and vegetables	Incorporating starch, carrageenan, nanocellulose (NC), *Aloe vera*, and hibiscus flower extract	Enhanced water vapor permeability, solubility, wettability, and moisture absorption; biodegradability and efficient UV radiation barriers	[24]
Dairy product	Carrageenan, cellulose derivatives (methylcellulose)	Keeping cheese and yogurt wet and stopping the oxidation of fat	[22]
Instant coffee powder	Edible films comprising κ-carrageenan/carboxymethyl starch/gum ghatti	Water-soluble edible films enhanced the stability of solid beverages.	[25]
Pork	Chitosan-gelatine edible coatings incorporating grape seed extract	Effectively prevented microbiological spoiling and pork oxidation; grape seed extract increased antioxidant activity against meat oxidation	[26]
Chicken thighs	EFs based on pectin from watermelon rind (*Citrullus lanatus*) with kiwifruit peel extract (*Actinidia chinensis*)	Reduced concentrations of peroxide and acid-reactive compounds were noted	[27]
Chicken meat	Composite EFs based on fish gelatin-pectin containing lemongrass essential oils (EOs)	Showed elevated TS, EB, antibacterial activity, and antioxidant activity	[28]

Table 2.
A list of edible packaging materials used for food item packaging and their effect.

substances, plant-based material's functional properties, durability, and quality of food have all been improved [30]. These materials produce no waste, are nontoxic, biodegradable, and include transport-active chemicals [31].

2.1 Polysaccharides

Polysaccharides are natural biopolymers that have different types of sources such as marine, microbial, plant, and animal (**Table 1**). The most prevalent natural macromolecule in nature is polysaccharide, which is employed extensively in the creation of food packaging [31]. Polysaccharides are made up of lengthy chains of polymeric carbohydrates joined by glycosidic linkages. They are harmless, colorless, tasteless, and selectively gas permeable. Alginate, cellulose, and pectin are examples of polysaccharides that provide a strong structure and effective gas barrier qualities [32]. Polysaccharides are also effective oxygen barriers. The sole drawback of polysaccharide-based edible packaging is its weak water vapor barrier capability, which is caused by polar groups that make the biopolymers hydrophilic [33]. The edible packaging cracks and flakes are due to the hydrophilic character of the biopolymers based on polysaccharides [34]. In response to growing environmental concerns brought on by the widespread use of plastic packaging, edible films based on polysaccharides have been researched extensively as food packaging materials. A chitosan (CS) and carboxymethyl cellulose (CMC) combination creates a binary edible film that has drawn a lot of attention recently [35]. Pectin-based packaging has found extensive use in both fresh and processed foods because of its barrier quality against physical factors such as moisture and gases; moreover, it also works as active ingredient carrier that helps in food preservation and extends the life of it [36].

2.2 Proteins

A polymer of amino acids, proteins have different sources such as plant, animal, and milk are being used in packaging (**Table 1**). Edible films are created by multilevel protein complexes. However, because the proteins have a higher atomization energy per unit volume, protein films are fragile and brittle. Reinforcing materials and active compound additions can be added to boost the film's functional and physical qualities [29]. Although protein coatings have limited water barrier qualities, they have comparatively excellent mechanical qualities and are good at blocking gases (CO_2, O_2) lipids, and fragrances [3]. Food quality has largely decreased because of lipid oxidation, which can be prevented by employing edible protein film that can stop oxygen from penetrating [37]. Because of their relatively high mechanical power, proteins can be used to guard fruits and vegetables against deterioration. Compared to lipids, polysaccharides and proteins have a hydrophilic nature and have inferior moisture resistance. However, the primary disadvantage of edible packaging related to proteins is their weak gas barrier properties that are caused by hydrophilic substances. As a result, a number of researchers have sought to create edible packaging made of polysaccharides and proteins that has strong gas and water barrier qualities by adding crosslinking agents [38].

2.3 Lipids

Lipids are being used in edible packaging of food goods [2]. Lipids have the ability of nonpolar solvents and also contain hydrophilic and hydrophobic character [8]. Wax and other lipids were initially used to cover citrus fruits [39]. Plants, animals, and insects are the natural source of lipids [29]. Lipids have comparatively strong moisture barrier qualities and minimal water vapor penetration. The moisture barrier effectiveness of plant and animal waxes is better than that of other types [40]. Lipids are fairly thick, easily broken, and demonstrate poor adhesion to hydrophilic foodstuffs. They also have weak structural and visual features [8]. Usually, lipids combine to proteins or polysaccharides to create a multilayer coating that enhances the film's ability to withstand with water absorption [1].

2.4 Composite

Researchers are now concentrating on composite-related edible packaging that is also referred to as multicomponent systems to boost the lifespan of food goods [41]. Utilizing the synergistic modifications in the film to overcome its particular shortcomings in certain qualities is the primary credo of composite film manufacture [39]. Composite films are generated from merging distinct polymers such as lipids, proteins, carbohydrates, and synthetic polymers. Protein-polysaccharide interaction produces a mono-phase film that possesses the improved mechanical character [42]. Combining protein and lipid results in a film with improved organoleptic qualities and stronger, better barrier qualities, which raises its commercial worth [1]. The quantity of biopolymers used determines whether composite edible films are binary or ternary. The combination of pectin with zeolite Y created a binary edible film

[43]. Chitosan, cassava starch, and whey protein were utilized in composite edible packaging for fruits with the enhanced physical characteristics [44]. Bio-composite films were made for active edible food packaging that are made of carrageenan/starch reinforced with nanocellulose [24].

2.5 Additives

2.5.1 Plasticizers

Low-molecular-weight substances known as plasticizers give a material more strength and flexibility. Because plasticizers have the ability to lower intermolecular tensions in polymers, they can be included in coatings or films to boost permeability to gases and water [8]. Monosaccharides, oligosaccharides, polyols and lipids, and their byproducts (fatty acids, surfactants) are often used as plasticizers in packaging [45]. Glycerol is frequently used to improve the mechanical properties of polysaccharide-based film and to keep starch-based goods wet [46]. Glycerol-sage seed gum film is one example of how adding various lipidic plasticizers to a film or coating can have a good impact. It has been shown that these plasticizers increase the film's thickness, moisture content, and moisture uptake [47]. The 3-D molecular arrangement of biopolymers is altered by plasticizers [48].

2.5.2 Emulsifiers

Because emulsifiers are both polar and non-polar, they function as surface-active agents that can mix immiscible liquids, such as water and oil. Because they aid in achieving the adequate wettability to the product, a prerequisite for appropriate area of the surface and the covering substance's adherence, emulsifiers are crucial. Because they are amphiphilic, many proteins exhibit emulsifying qualities [8, 49]. Significant emulsifiers include natural lecithins and other common emulsifiers include glycerol monopalmitate, sodium lauryl sulfate, acetylated monoglyceride, glycerol monostearate, polysorbate 80, sorbitan monostearate, etc. [50].

2.5.3 Antimicrobials

Additives called antimicrobial chemicals are used to prevent the growth of microorganisms, including harmful ones, and to regulate biological deterioration. Antimicrobial agents are frequently administered directly to the food for packaging. Edible films may contain a variety of antimicrobial ingredient types [51]. The best way to prevent additional food contamination and deterioration would be to use the antibacterial treatments. Every antimicrobial drug has a distinct function and responds differently to most bacteria [52]. Bacteriocins are the peptides that inhibit bacteria's growth [53]. The limited research on bacteriophage-treated edible films and coatings was covered. Food items can be preserved by phage-added edible packaging, which also contains strong antibacterial qualities [54]. Investigating insects as a source of antimicrobial peptides may help to find substances that can stop the growth of a variety of pathogens in various dietary applications and can be used in edible packaging [55].

2.5.4 Plant extracts

The extracts are made from a variety of plants and their parts. Their antibacterial qualities are mostly because of phenolic compounds, which are present in different parts of plants and spices [56]. Phenolic substances are bioactive and show antibacterial and antioxidant properties and are found in oil extracted from plants such as radish, clove [57]. Foods can include natural antimicrobials without the use of preservatives or other antimicrobials. Plant-derived extracts in a polymer substrate provide packaging materials their different qualities, such as physical, antioxidant, antibiotic [2].

2.6 Others

Biopolymers include organic acids, plant extracts, antibacterial compounds, essential oils, probiotics, and prebiotics, as well as other active agents. They are nontoxic, environmentally benign, biocompatible, and biodegradable [2]. To be environmentally friendly, biodegradable polymers are frequently chosen. Marine seafood, plants, and algae are valuable sources of natural polymers that may be utilized to create environmentally friendly packaging. Historically, the earliest materials utilized for food packing by ancient cultures were various natural materials, such as plant and animal parts, shells, pottery, and others [58]. Foods such as green bell peppers, guavas, blackberries, pineapples, cheese, strawberries, and shrimp were also used in edible packaging [48].

3. Edible films and coatings

According to estimates, the global edible coating and film market in 2020 was USD 2.06 billion. The Food Safety Act of 1991 requires that the framework regulations EC 1935/2004 be followed when using food packaging and other contact packaging materials. According to this law, no dangerous substances should be released into food items by packing materials in amounts that might endanger human health [2].

3.1 Edible films

Flat-layered sheets are used as food covers that can be eaten with the dish and may be detached [59]. Films can be used to make wraps, pouches, bags, capsules, and casings [5]. Edible films are prepared first and then applied on food for packaging (**Figure 1**) [1]. Film-forming materials must possess filmogenic qualities and be biopolymers [3]. The choice of plasticizers and solvents is based on how well they work with the chosen polymer. Solvents that dissolve polymers and change the physical and barrier properties include water, alcohol, and others [60]. In order to reduce water loss, stop leaks, and lessen food contamination and spoiling, hydrophobic coatings are also placed on the inside surfaces of packing films [61]. There are different types of formation processes of edible films, like wet and dry processes [14, 62].

3.1.1 Wet process

To create a film, the wet technique involves homogenizing the film-producing ingredients with a solvent and then drying them. Biopolymers are dissolved in solvents in first step. Then, matrix substances are incorporated with additives and enhanced the heat and pH of the solutions to make them more soluble. A surface that is flat is covered with a film-making fluid, which is then left to dry at an appropriate temperature and humidity level. Food products can be wrapped with the generated

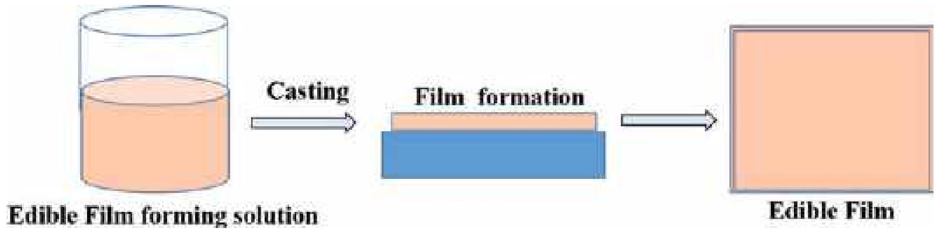

Figure 1.
Edible film formation.

film. During the casting process, the film-forming fluid is transferred onto a teflon-covered glass plate or a prefabricated mold. A mold-attached polymer film is created by solvent evaporation during the drying stage [3, 63].

3.1.2 Dry method

The thermoplastic tendency at low moisture content is used in a dry procedure to transform the additional ingredients into films [64]. This method is diverse and includes the different processes.

3.1.2.1 Extrusion process

In this process, three main steps are i. Feeding, ii. Kneading, and iii. Heating [65]. In addition to using less energy and time to manufacture the material, this method offers superior physical qualities. It is a popular commercial method that provides excellent performance at a fair price [1, 3].

3.1.2.2 Compression molding method

It is regarded as a sustainable process because of its quick formation and minimal energy requirements. The material within the film-making mold is heated and compacted until it solidifies. Another element that affects the film's characteristics is time related to the processing. Prior to the primary thermoforming process, the film-forming material is often prepared using this stage in conjunction with the extrusion method [3].

3.1.2.3 Injection molding method

The pressure of injection, heating of mold, and prior to injection pressure heating are the parameters of this three-stage process, which includes filling, packing, and cooling [66].

3.1.2.4 Electrospinning method

The process is generally carried out as jet starting, extension, and solution hardening. A syringe or capillary tube is one of the components of an electrospinning process that transfers solution to a high-voltage battery, which then produces nanofiber and collects the solution with the aid of a collector [1, 67].

3.1.2.5 Thermoplastic method

The thermoplastic process constantly shapes the materials using high temperatures, shear pressures, and minimal water, enabling the production of films on a commercial basis [68].

3.2 Edible coatings

The food items are effectively coated by the edible coating (EC) materials. Covering, dipping, and spraying are the examples of processes (**Figure 2**); moreover following drying, the food develops an edible coating that may be eaten or removed [5]. The powder, emulsion, or liquid suspension solution can be employed on food surfaces. There are different types of preparation methods of edible coatings.

3.2.1 Dipping method

This method is traditional and widely used [63]. It entails dipping an item directly into a liquid coating solution, taking it out, and then letting it air dry to generate a membranous coating that covers the outer structure of food items [3].

3.2.2 Spraying method

This approach is best suited for items with broad surfaces using pressure (60–80 psi) to cover the food-related item's outer structures and surfaces [66].

3.2.3 Fluidized bed method

Putting an extremely thin coating on dried particles that have very low sizes (density) is known as fluidized bed processing. A fluidized bed that rotates is filled with the tiny particles that need to be coated. Centrifugal force and airflow work together to efficiently offset the overall force imposed on the food particles [65, 69].

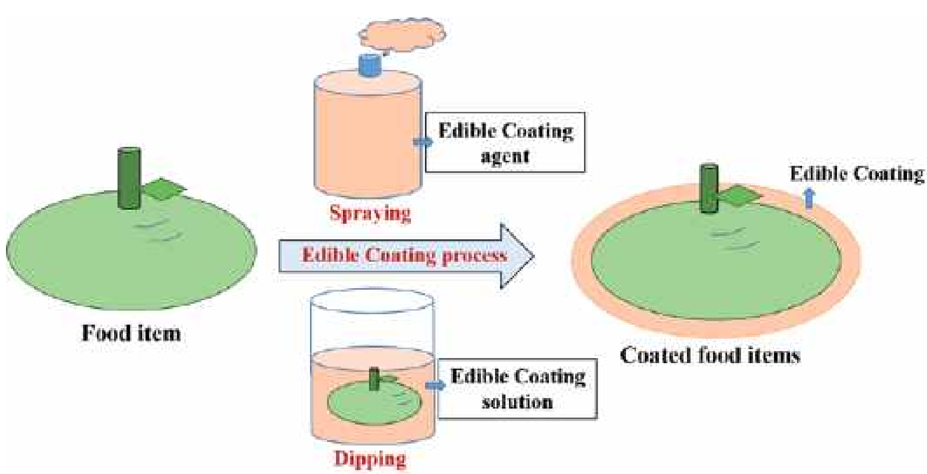

Figure 2.
Edible coating process of food item.

3.2.4 Drum coating method

Drum coating is one method for adding a significant thin and thick coating to a harder object (nut). It is used on salt and oil nuts, which improves their flavor and palatability while delaying oxidation. This coating technique aids in delaying the absorption of moisture in chocolate [1].

3.2.5 Pan-coating method

The pan-coating technique is suitable to create thin coverings and thick coverings of coating on hard, almost spherical particles that may give the coated product more tastes while halting the loss of lipids and moisture. This process involves placing the object to be coated inside a huge rotating bowl, which serves like a pan. Employing a ladle and a spray, the coating solution is poured into a rotating pan having food items for surface coating [69].

4. Edible packaging related to beverages

Beverages are being packed by edible packages. Drinks are frequently enclosed in coatings or films. Alginate capsules create a liquid container that forms a barrier that keeps the liquid inside for beverage packaging. A product's surface can be directly coated with the edible materials to provide protection. But many edible materials dissolve readily in water and have a short shelf life, moreover that can cause allergies while using natural ingredients in edible packaging [5]. Biomaterials such as seaweed, chitosan, gum, starch, and other materials are used by Patil et al. [70] to make edible straws. Injection molding, screw extrusion, rolling up, and other techniques are used to prepare them. Paper, plastic, and PLA straws are inferior to edible straws. These chemical-free edible straws go well with a variety of drinks and beverages [70]. Biodegradable edible cups have been created to collect the hot drinks. Material of the cups (cookies) was thick and could be taken in a hand. The drink can be kept in the edible cup for 20 minutes to 1 hour. Under the influence of drink, the cup remained unchanged [71]. Wheat flour, cocoa bean, coffee, palm oil, sodium bicarbonate, and sugar had been used by Anand et al. [72] for the formation of edible cups for coffee. Each cup has volume 180 ml (weight 22 g) and it was baked in an industrial oven for about 30 minutes. Eating cups have been suggested as a way to reduce plastic pollution and littering caused by the annual waste of 500 billion drinking cups [72].

Wu et al. [25] created an edible packaging film using a mixture of gum ghatti, carboxymethyl starch, and κ-carrageenan that dissolves quickly in water. This film has been applied in instant coffee powder packaging, where the film also increased instant coffee's (solid beverage) stability [25]. The strength performance of film was boosted when sodium alginate (SA) was added to potato starch (PST); moreover, fruit and vegetable juices were incorporated in PST/SA films that demonstrated the excellent antioxidant properties and good visual appeal [73]. Using the solvent-casting approach, polysaccharide-centered edible films were created using jambolan and grape juices by Chambi et al. [74]. This film demonstrated good flexibility and resistance to mechanical force [74]. Green tea extract was added to edible film of soy protein and antimicrobial activity was observed [75].

5. Benefits and drawbacks

Edible packaging materials decompose naturally and can be eaten or thrown away without harm. Frequently, the integrated composition contains vitamins and plant extracts that are good for health, improving the health of the customer. Industries related to food, medicine, nutraceuticals, agrochemicals, etc., are utilizing the edible films. Edible packaging is available in a number of forms, including films, coatings, soluble strips, flexible pouches, microcapsules, straws, cups, and capsules. Edible packaging opens the door for packaging the materials that are easily damaged (fruits and vegetables). Less use of traditional packaging improves the environmental effect and lowers waste output [29, 73].

There are some limitations while using the edible packaging, such as the fact that new edible wrappers are more costly than synthetic packaging. They would be used to wrap foods within a secondary synthetic package while delivering and preserving food. They would not be employed exclusively, where unhygienic circumstances during food handling may arise. Developers, however, believe the nutritional and environmental advantages will offset the increased cost. Edible packaging occasionally has an odd flavor and poor mechanical qualities. To prevent hygroscopicity and microbiological growth, edible packaging needs to be carefully chosen [1]. It could be necessary to use antimicrobial agents. Some ingredients employed in edible packaging, such as beeswax, may trigger allergic responses in people. There is a dearth of information regarding edible film and coating equipment, materials, and application methods [29].

6. Future perspectives and conclusions

In order to prevent food waste and environmental contamination, the significance of sustainable and long-lasting packaging materials has increased dramatically. Bio-based products flourish in the excess, such as bioplastics and wood-based paperboard. But there is still a long way to go before petroleum-based products in the packaging industry can be replaced with bio-based ones. An eco-friendly, inventive, and green solution that has the potential to replace synthetic packaging is edible packaging. Edible packaging is a significant way to boost the life of food-related items. Biopolymers of natural sources are used to construct edible packages. By decreasing weight loss, water transpiration, and the barrier against gas transmission, edible packaging is useful for storing the characteristics and sensory qualities of many food-related substances. Because of its superior barrier qualities, composite packaging is preferred over edible coatings that are made from a single polymer. A variety of edible packaging techniques are employed, including composite packaging, active packaging, etc. Moreover, nanotechnology is being used in packaging because of its superior mechanical, thermal, optical, and antibacterial qualities. Edible packages preserve color, flavor, and other inherent qualities. Active ingredients like plant extracts and essential oils can function as organic antimicrobials by preventing the growth of dangerous microorganisms in food products. Moreover, every additive has a unique purpose or impact on edible packaging. The industrial community has been increasingly interested in the idea of smart food packaging, but factors like cost, processing needs, energy usage, mean conventional packaging cannot be fully replaced. To comprehend layer-by-layer packing, commercial application, edibility, the scaling-up process, and other topics, more research is required.

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