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NATURAL EDIBLE FILMS: A REPLACEMENT TO SYNTHETIC PACKAGING MATERIAL

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ABSTRACT

Edible packaging usually consists of a waste-free, sustainable, biodegradable material that is applied as a consumable wrapping or coating around the food. Several recent researches have looked into the value of edible materials as a supplement. Polysaccharides, Proteins, and Lipid-Based Polysaccharides, Proteins, and Lipid-Based Polysaccharide edible films around the food's surface are made from natural edible polymers. Polysaccharides, lipids, and proteins are the three types of natural edible polymers. Consumer preferences are shifting toward more natural, high-quality, convenient, and safer foods, offering a substantial challenge to the food processing industry, as environmental concerns about the increasing rate of waste produced by packaging materials grow. As a result, there has been an increase in awareness and study as well as industry focuses on edible materials that can improve food safety and quality. The value of several natural polymers used in edible films is summarised in this review article.

Keywords: Edible Film, Polysaccharide, Protein, Lipid, Edible Packaging.

I. INTRODUCTION

Food packaging is an integral part of the food supply chain and is increasingly becoming an important part of the final preparation process in food processing plants. Food packaging is especially important in society since it protects food and food items from potential damage and degradation caused by food hazards, while also maintaining food safety and cleanliness and actively decreasing food waste [1]. Food packaging systems provide a number of purposes, including information, confinement, and marketing. The primary purpose of packaging is to keep food isolated from its surroundings, decreasing contact with spoiling factors (such as microbes, moisture, air, and off-flavors) and preventing the loss of beneficial chemicals (such as volatile flavours), thereby extending the shelf life of food [2]. Food packaging should also prevent unfavourable changes in food quality (colour, flavour, taste, and aroma), microbe development, lipid oxidation, and nutritional degradation. Despite relatively high recycling rates for some materials (over 20% for some paper and paperboard), conventional packaging materials caused significant environmental damage. Others, such as some plastics, are regularly recycled at low recycling rates (less than 20 percent) [3].

Consumer preferences are shifting toward more natural, high-quality, convenient, and safer foods, offering a substantial challenge to the food processing industry, as environmental concerns about the increasing rate of waste produced by packaging materials grow. As a result, there has been an increase in awareness and study as well as industry focus on edible materials that can improve food safety and quality. To extend the shelf life of edible films, starches, cellulose derivatives, chitosan/chitin, gums, animal or plant-based proteins, and lipids can be used [5]. Biopolymer materials such as pectin, carrageenan, alginate, starch, and xanthan gum have been employed to generate coatings and edible films to eliminate traditional plastic packaging [4]. The properties and characteristics of the food that needs to be protected, as well as the application, determine the barrier requirements of edible films. Films for fresh vegetables and fruits should have low water vapour permeability to reduce desiccation, while oxygen permeability should be low enough to prevent respiration but not so low that anaerobic conditions are created, resulting in off-flavor development and ethanol generation [6]. Consumer expectations and wants today are for more natural, high-quality, cost-effective, low-pollution, sustainable, and safer foods all around the world. Therefore, this review describes briefly the types and uses of natural edible films for food packaging.

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II. TYPES OF MATERIAL FOR NATURAL EDIBLE FILM

EDIBLE FILMS BASED ON POLYSACCHARIDE

Polysaccharides are one of the materials that has lately been employed as a sustainable ingredient in the development of coatings and edible films. Polysaccharides are nontoxic and abundant in nature, and they have selective permeability to carbon dioxide and oxygen. Polysaccharide-based coatings and edible films can extend the shelf life of fruits because of these properties. Biopolymer materials such as pectin, carrageenan, alginate, starch, and xanthan gum have been employed to generate and edible films to eliminate traditional plastic packaging [7].

Animal origin: Chitin is the second most abundant biopolymer in nature after cellulose. Chitin can be found in crab exoskeletons, fungal cell walls, and other biological components. Chitosan is made by deacetylating chitin; it's a high-molecular-weight cationic polysaccharide with excellent film-forming properties and antibacterial and antifungal properties [8]. It has been employed in the biomedical, food, and chemical sectors because of its properties such as nontoxicity, biocompatibility, and biodegradability. Food coated with chitosan films reduces oxygen partial pressure in the packaging, maintains temperature with moisture transmission between food and its surroundings, slows enzymatic browning in fruits, regulates respiration, and reduces dehydration. Furthermore, chitosan is utilised to improve the emulsifying action, increase natural flavour, establish texture, deacidify, and stabilise colour [9]. Clear, flexible, and durable chitosan-based films are available. They are resistant to fats and oils, as well as oxygen, but they are extremely sensitive to moisture [10].

Plant origin: The most abundant organic compound on the planet is cellulose. It's made up of dglucose units connected by -1,4 glycoside linkages. Its derivatives, which are biodegradable, odourless, and tasteless, are mostly utilised to make naturally edible films [11]. Starch is a natural polysaccharide that is used to make biodegradable films because it is translucent or transparent, flavourless, and tasteless. Starch granules absorbed water molecules surrounding free hydroxyl groups, causing them to enlarge, which continued until a critical concentration was reached [12].

Pectin is a polysaccharide that can be found in a variety of vegetables and fruits, including apple pomace and citrus peel. Pectin is an anionic polysaccharide having a (14)-linked -d-galacturonic acid unit as its structural backbone. It's used in yoghurts, milk, ice cream, and jams as a stabiliser, thickening agent, and gelling agent. The mechanical properties of pectin-based edible films reveal great mechanical capabilities, an excellent barrier to oil and fragrance, oxygen, and a high initial modulus, but they have poor moisture resistance, low elongations, and are brittle; the addition of plasticizer makes them more flexible [13]. Arabic gum is derived from the stems of numerous Acacia species and is the most widely used polysaccharide in industry due to its film-forming, encapsulating, and emulsification capabilities. Galactose, rhamnose, arabinose, and glucuronic acid make up this sugar. The respiration rate and ethylene generation of fruits covered with Arabic gum or almond gum were significantly reduced [14].

Microbial origin: Pullulan is a microbial polysaccharide made up of maltotriose units connected by 1,6 glycosidic units and produced by Aureobasidium pullulans from starch. These films are odourless, colourless, heat-sealable, tasteless, transparent, water permeable, and low oxygen and oil permeable. Gellan is a kind of polysaccharide generated by the bacteria Sphingomonas elodea (also known as Pseudomonas elodea), which has unusual colloidal, coating, and gelling properties [15]. The bacteria Xanthomonas campestris produces xanthan gum, which is an exopolysaccharide. It produces a viscous solution in hot or cold water over a wide temperature and pH range, and it is resistant to enzymatic destruction [16].

EDIBLE FILMS BASED ON LIPID

Lipids are naturally occurring molecules found in mammals, insects, and plants. Phospholipids, phosphatides, mono-, di-, and tri-glycerides, terpenes, cerebrosides, fatty alcohol, and fatty acids make up the diversity of lipid functional groups. Triglycerides are the main components of fats and oils, which come from animals and plants, respectively. Hydrophobic and volatile materials abound in essential oils. Because of the terpenoids, terpenes, and other fragrant chemicals found in them, they have potent antibacterial properties. Citrus essential oils of peels from lemon, mandarin, and orange on methylcellulose or chitosan films were made by [17]. Waxes are beneficial in edible films because they effectively reduce moisture permeability while maintaining high hydrophobicity [18].

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EDIBLE FILMS BASED ON PROTEIN

Proteins can be found in nature as fibrous or globular proteins; globular proteins are rolled over one another, whereas fibrous proteins are joined in parallel. Among the proteins that can be employed in edible films are lactic serum, caseinate, and collagen. Protein films have greater mechanical qualities than polysaccharides because of their unique structure. However, as compared to synthetic polymers, protein films have a lower mechanical strength and have a larger water vapour permeability [19]. Milk proteins generate films that are flexible, flavourless, and translucent. From aqueous caseinate solutions, casein produces edible films. Although these edible coatings provide a stronger oxygen barrier at low or moderate RH, they have a low water vapour permeability [20]. Before processing meat products, the meat industry employs collagen films. When heated, collagen film works as an edible skin that aids in the cooking of meat products [21]. Gelatin is dissolved in hot water to make an edible film, then the dispersed solution is cast on a plate and dried in an oven [22]. Gelatin-based edible films offer higher film thickness and mechanical qualities as protein content increases, while water vapour permeability decreases [23]. Corn's major protein is zein, which is a polyamine. Because it is glossy, water-insoluble, bacteria-resistant, antioxidant, and forms sticky film, it is a virtual hydrophobic and thermoplastic material.

EDIBLE FILMS FROM FRUIT PUREES

Fruit purees (such apricot, apple, peach, banana, tomato, mango, carrot, and pear purees) can be used to make edible films. Fruit purees are mostly made up of cellulose and pectin. Typically, films made from fruit purees have limited flexibility. To increase their hardness and processibility, plasticizers could be added. To increase the qualities of fruit puree composite films, fibre or particle addition could be used [24]. Mango films could be used to extend the shelf life of fresh-cut mangoes because mango puree has high oxygen barrier qualities [25]. Carrot pulp films have a high oxygen resistance, so they could be used to protect foods from oxidation [26].

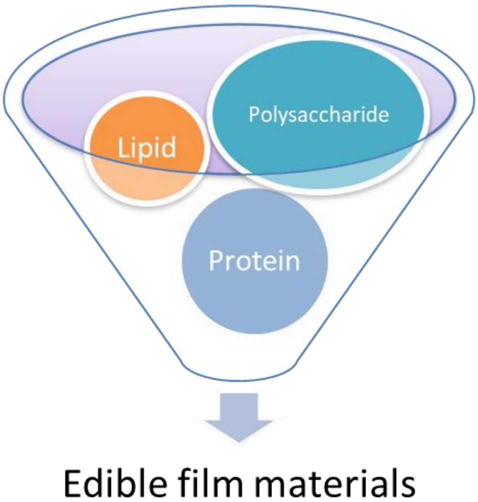

Fig 1: Materials for edible film

III. ADVANTAGES OF NATURAL EDIBLE FILM

As demonstrated in Fig. 2, edible film packaging has a variety of applications and benefits. Edible packaging can be used as a substitute for and potential addition to the layers on the outer surface of packaged products to prevent moisture, aromas, and ingredients from escaping and being transferred between foods, while also allowing for the controlled exchange of essential gases involved in food product respiration (carbon dioxide, oxygen, and ethylene) [27]. Edible packaging can improve the organoleptic features of packed meals by adding different flavours and colours, as well as customising surface properties (i.e. hydrophobicity, hydrophilicity). Furthermore, they can act as a carrier for functional components that may have additional health or well-being advantages [28]. Polysaccharides can also act as oxygen barriers, whereas proteins have a high mechanical strength and can be employed to protect fruits and vegetables during transit. Lipids, on the other hand, have a low water vapour permeability and a good moisture barrier. The colour, flavour, sweetener, and salt concentrations are frequently preserved in lipid-based edible packaging, which is often opaque, waxy tasting,

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and slippery [27]. Food quality is principally determined by moisture and oil absorption, oxygen transfer, flavour and aroma modification, and packaging component migration into the food [29].

Edible materials are typically applied to food by immersion, spraying, or coating, or by being made prior to being wrapped in a film and utilised as a food wrap. The edible ingredient is commonly dissolved in water, alcohol, or a combination of solvents to make films. Additives such as plasticisers are included in matrix material to improve the flexibility and durability of these composites [30]. The use of edible packaging materials as a matrix and carrier of various functional additives that can provide additional nutritional and health advantages to packaged food is one of the key growing roles of edible packaging materials. To lengthen shelf life and/or boost the nutritional content of the final packaged product, antibacterial and antioxidant compounds, prebiotics, and other nutrients are commonly added to edible matrices [31]. Antioxidants can be added to edible materials to slow down the pace of oxidation reactions and improve the safety and quality of the food. These chemicals can inhibit the activity of free radicals through a variety of mechanisms, including functioning as free radical scavengers (e.g. glutathione), chain-breaking antioxidants (e.g. ascorbic acid), and preventative antioxidants that can attach to particular metal cations (i.e. albumin) [32]. Several investigations have found that it has antibacterial properties against various microorganisms, including human diseases. Incorporating these natural substances into product formulations or packaging materials can help improve oxidation stability as well as limit fungal development. Essential oils may impact the organoleptic characteristics of food and possibly operate as a flavour component, in addition to their beneficial properties [33].

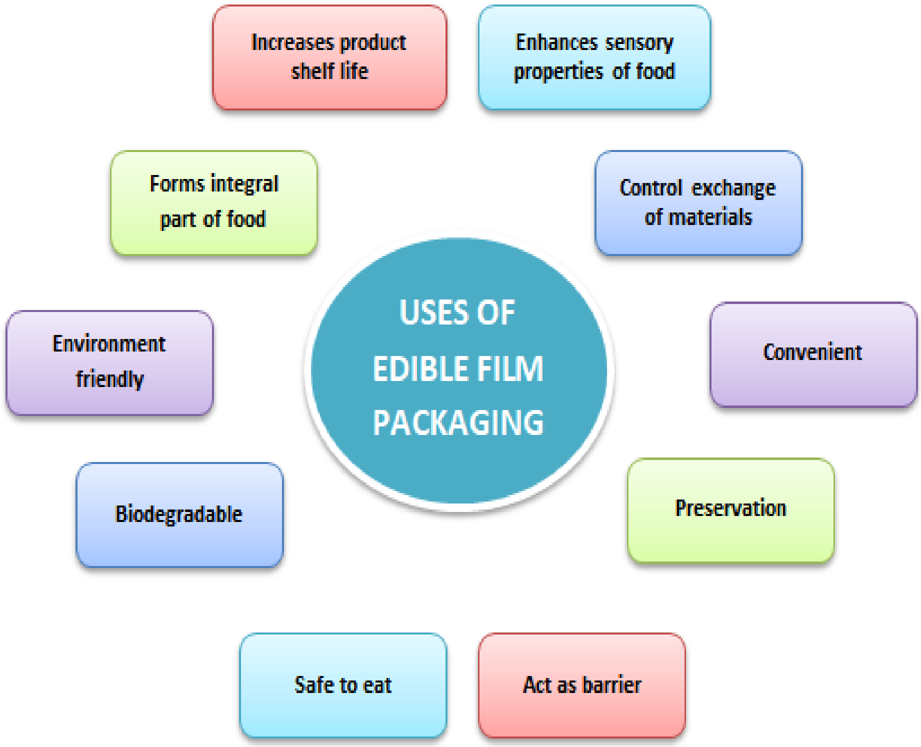

Fig 2: Uses of edible film packaging

IV. CONCLUSION

Novel packaging options for a variety of food goods are generating a lot of buzz throughout the world. New packaging methods have made it possible for freshly designed products to perform better than before by offering confinement and physical protection. The future of edible packaging materials is bright, as increased food industry innovation is both coming and now happening. Global consumer demand is driving revolutionary material research and development in order to identify alternatives to fossil-based packaging materials. Consumers and the food business both want recyclable, biodegradable, or edible materials made from renewable and sustainable resources to replace them. Biopolymers have the advantages of biodegradability, process simplicity, and a low cost of production in this context.

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