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Review Article

Role of Polysaccharide Based Edible Packaging in the Meat and Dairy Products: A review

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Abstract

Currently food technologists are facing main problem is to enhance the shelf life and preserve the fresh items of food (such as meat and milk etc.) those are accomplishing our daily demand for nutrient requirements. Moreover, food packaging is away from the simple conservation; modern techniques have focused for the satisfaction of dual objects, firstly the appropriateness used methods, that should eco-friendly and non-toxic to human beings and secondly, it must be biodegradable. Furthermore, they are also looking for additional nutritional properties. In preservation and packaging techniques one is deal with organic polymer such as polysaccharide as edible packaging and their application in form of film and coatings that are digestible. Also, particular attention has been paid to the components mostly utilized additives in edible packaging, their preparation methods of edible coating and films and their application to meat and dairy products. This review illustrate an overview to the current state use of edible film and coatings as an alternative to conventional packaging, that provides the key role that these eco-friendly packaging should come across with specific uses for the improvement in shelf life and protection of various food products especially in meat and dairy products.

Keywords: Edible films; Coatings; Milk; Meat; Packaging.

Introduction

One of the major issues facing the world is producing healthy and safe food with packaging material that is lack of synthetic ingredients. Over the previous 70 years, in world a massive increase of plastic from five to two hundred and thirty million tons/annually. Traditional plastic-based material has several drawbacks in terms of environmental and human health; they might take months to years to decompose, depending on the kind and origin of the polymer (Morales-Jiménez and Gouveia, 2020). To overcome this critical issue global efforts are being made to minimize the effect on health and environment (Erkmen and Barazi, 2018). As consumer's demand for natural, healthy, and nutritional food rose, in this edible packaging is safe and natural has become an attractive option. Biopolymers such as lipids, polysaccharides, and proteins used in packaging are digestible and biodegradable (Erkmen and Barazi, 2018; Molina-Hernández et al., 2020). By the application of

lipid to dairy products, meat or their products can cause the development of undesirable taste, while the protein in nature has low water permeability and among these the polysaccharides are best due to its colorless, oil free and dehydrating properties (Mihalca et al., 2021).

Polysaccharides are hydrophilic and high molecular weight carbohydrate which in water forms hydrogen bonding to create the gel structure. Cellulose derivatives, starch, pectin, alginates chitosan, pullulan and carrageenan are the mostly used polysaccharides (Song et al., 2021). Theseare used in various food products in form of edible films and coatings which comprises of different components. Due their best mechanical and structural properties they are preferably used in edible packaging i.e. film and coatings. Edible films are structures for wrapping or interleaving products while an edible coating material is in liquid form directly applied to the food surface that are made from biological macromolecules in order to achieve a thin thickness (layer of material) that acts as a barrier from moisture, gases and oils etc. and prolonging their shelf life (Senturk Parreidt, 2018). As polysaccharide are digestible so they are achieving both the idea of food preservation and packaging into a biodegradable film and coating that prevents colour declining, lipid oxidation, moisture loss, extends shelf life, off-odors and adds functionality to food. Meat and dairy are perishable products because of their high protein, mineral, vitamin, and micronutrient are important part of the modern diet in the entire world. World production of meat is 334.47 million metric tons in 2021, and meat productivity is predicted to expand by 44% to 481 million metric tons in 2030 (Statista, 2022). This means that as the production and consumption of meat rose, the need of packaging materials raise as well. For successful application of edible packaging in meat and dairy, the material used for film or coating preparation must meet the moisture, wettability, temperature and appearance range of food item (Erkmen and Barazi 2018; Morales-Jiménez et al., 2020). Dairy and meat products require adequate processing and handling and safe packaging to enhance their shelf-life. The impact of composition, air, light, and processing temperature (Wang et al., 2021) results in physical, chemical, and sensory alteration. At this, adding functional agents into packaging that might prevent or limit deterioration processes has emerged as a reasonable approach to green preservation. For meat and dairy, the use of active agents in edible films in solution provides the packaging both antibacterial and antioxidant protection (Song et al., 2021). The functionality of active component depends on the nature of component, preparation method and nature of food on which it is applied. This review includes an overview on sources of polysaccharides used, various preparation techniques of edible film and coatings, preservative role in dairy and meat products, a descriptive incorporation of novel active compounds that are eco-friendly with excellent antimicrobial, antioxidant, surfactant barrier properties and suitable for food preservation.

Polysaccharide based material used in edible packaging

To create an edible packaging (films or coatings), many bio-based polymers have been examined. The most prevalent group of biopolymers utilized in the manufacturing of edible materials is polysaccharides. The polysaccharides are used in formation of edible

film and coatings can be obtained from different sources such as plants, animals or microorganisms (Galus, 2020). Their classification of different sources is expressed below in figure 1.

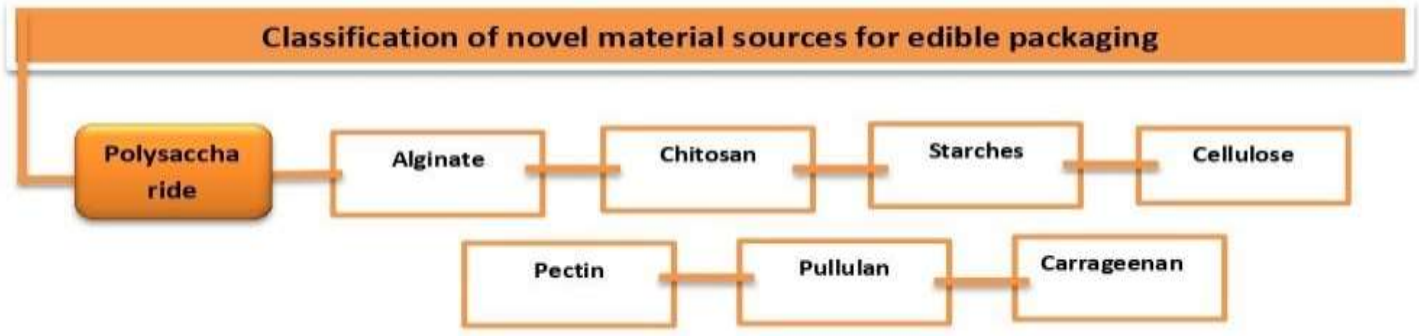

Figure 1. Classification of novel material sources for edible packaging.

Polysaccharides are widely used in the world to form edible film and coatings because of its non- toxic nature and selective permeability to O2 and CO2. The chitosan, pectin, alginates, cellulose, and carrageenan are mostly used due to its excellent gas barrier and preventing dehydration properties (Hossain et al., 2021). Starch is universal biopolymer, made of monosaccharide units, abundantly found, low cost, good gelatinizing and mechanical properties, it is important in film and coating formation. Starch based edible film and coatings are very brittle colorless, non-toxic, odorless, isotropic. Chitosan is abundantly available polysaccharide obtained from deacetylation of chitin using alkali compounds (Costa et al., 2018). It founds in the invertebrates, marine diatoms, alga, fungi, and insects, consists in a natural, safe, biocompatible, and allergen-free, carrying various health benefits. Chitosan is an important component in the preparation of edible packaging i.e. coating and film, for the most part due to its good structural properties that is useful in coating of the final food item. Furthermore, its good antimicrobial, antioxidant, oxygen, and carbon dioxide barrier properties, made chitosan as good alternative for edible food packaging (Shendurse et al., 2018). The major obstacle of chitosan to apply in edible coating and films is the chance of occurring undesirable effect on the sensory properties on the final food item. Chitosan film and coatings are normally applied to fruits and vegetables due to their ability to delay the natural ripening process. Chitosan application as chitosan extract or as chitosan nanoparticles into edible coatings with pomegranate peel extract, to protect natural products against different type of bacteria and fungi (Pelissari et al., 2019). Research including the production of edible coatings by chitosan with olive oil as active agent was also performed by Zhang et al., (2021), which lead to control of the microbiological action and, subsequently, the protection of meat products. Asa natural polysaccharide, alginates is derived from brown algae species, generally applied in the film and coatings due to its particular colloidal properties, such as thickener, film formation, gel formation and emulsion stabilizer. The vital features of the alginate-based coating and films are molecular weight of the polymer, reduce drying, control food respiration, and improve in appearance (Zuhal and Kerse, 2021; Parreidt et al., 2018).

Alginate- based films are used to develop the quality and shelf life of the meat and other than meat such as fruits. Researcher Zhang et al. in (2021) evaluated the impact of applying edible coating and films with sodium alginate and its coatings joined with lemongrass basic oil (Marales-Jimenez et al., 2020),conducting both to effective results in food. Pectin is heteropolysaccharide assimilated from vegetable and fruits. Mainly it obtained from apple juice wastes and citrus peel. It also forms clear and homogenous film, but it has poor moisture and barrier properties. Cellulose is also found abundantly in the world. Cellulose includes carboxymethyl cellulose (CMC), hydroxypropyl methyl cellulose (HPMC) and methyl cellulose (MC) (Díaz-Montes, 2021). In all form cellulose has unique characteristics as structural stability, film formation as it is tasteless, odorless, colorless, and flexible, water vapour and oxygen permeability. Methyl cellulose is most resistant to water as it has low hydrophilic nature but form strong film as compared to HPMC. Wang et al. (2021) studied that methyl cellulose coating (2.5%) can improve the cooking quality and reduce the frying losses (Wang et al., 2021).

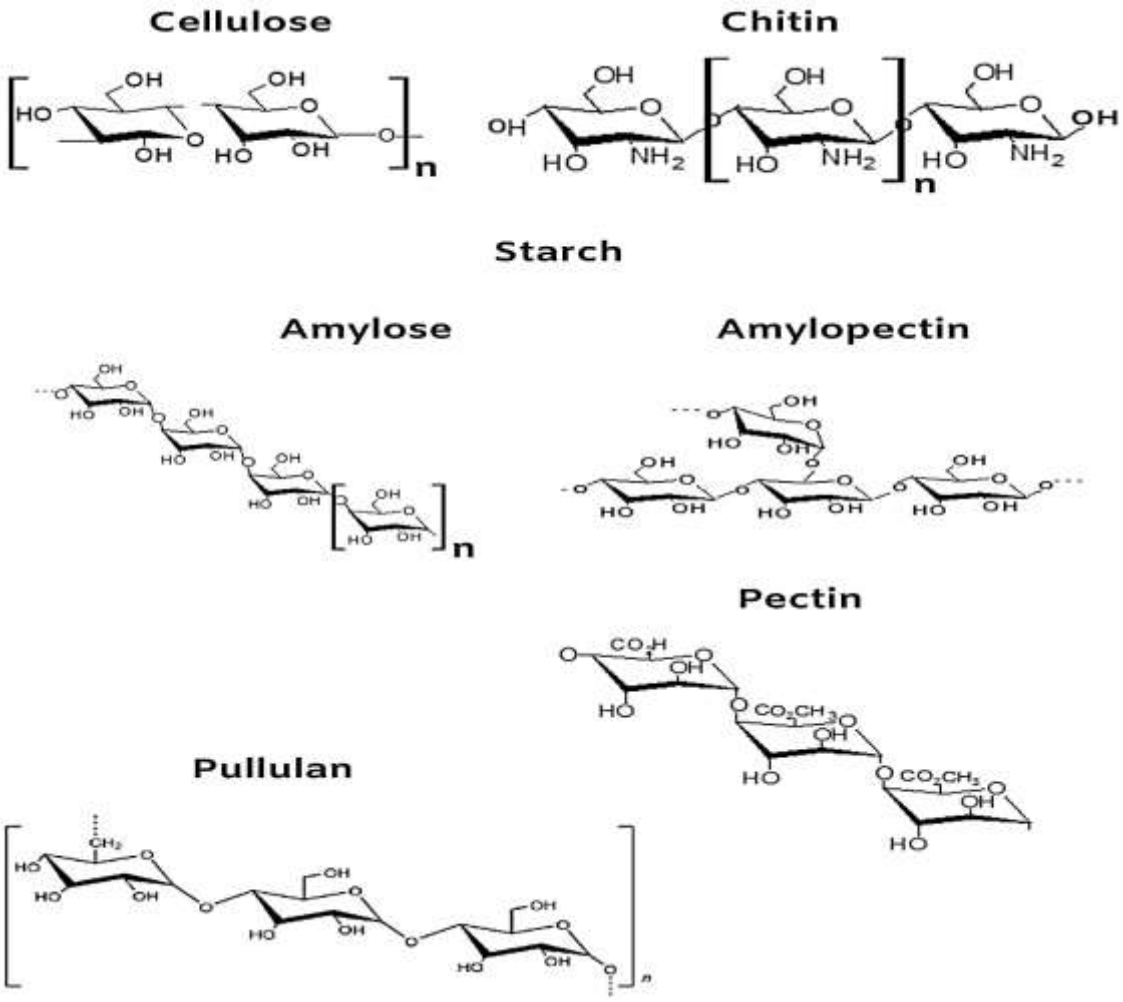

Figure 2. Polysaccharides chemical structures in edible film and coating formation.

Edible packaging is an old technology that has been used to protect the food items and prevents food component from declining. The time advancement of this type of packaging is briefly represented in table 1. Unlike an edible coating, which is applied directly to the food surface, an edible film is created separately and then incorporated into food products by being placed on or between food components (Senturk et al. 2018;

Zhang et al., 2021; Mahcene et al., 2021). Even though they serve the same purpose in the product, film and coatings have immensely different appearances. Coatings must be applied in a liquid form, usually by dipping the food in a solution, whereas film must be moulded first as solid sheets before being put as a wrapping on the final product (Molina et al., 2020).

Table 1. History in food packaging techniques adapted from 1400-2000.

Year (A.C)	Invention in packaging	References
1400	First edible film formation in Japan ("Yuba"films with soymilk protein)	Galus 2020
1869	First US patent for gelatin films to protect meat products	Jeevahan and Chandrasekaran 2019
1900	36 Fruits and vegetables are coated by using polymers	Molina-Hernandez 2020
1935	Discovery of aluminum for coatings	Zhang et al. 2021
2000- current era	Invention and application edible film and coatings	Wang et al. 2021, Erkmen and Barazi 2018

Preparation method of edible packaging

Edible film and coatings are thin layers, usually less than 0.3 mm thick, that is used to protect the food, improves the quality of the final product, and can be consumed as a whole. (Zuhal and Kerse 2019; Parreidt et al., 2018). Even though they serve the same purpose in the result, films and coatings have very different properties. The different materials used in edible packaging with their technique of application and active agent are discussed in following Table 2.

Table 2. Brief description of material used in film or coating of different products and their application technique to food.

Polysaccharide	Coating technique	Additive	Food	Effect	References
Alginate and CMC	Wrapped	Glycerol & terminalia, cinnamon	Sausages	Shelf lifewas extended	Pérez-Vergara, Cifuentes and Andrade-Pizarro 2020
Carrageenan	Dipped	Glycerol & beeswax	Sausages	Weight loss was reduced	Ribeiro, Estevinho and Rocha 2021
Gum Arabic	Wrapped	Sorbitol & xanthoxylum rhesta	Chicken meat	Improve shelf life and nutrition	Subroto, Indiarto, Pangawikan and Prakoso 2021
Galactomanan and chitosan	Spread	Glycerol, sorbitol & corn oil	Cheese	Shelf life was improved	Mahcene et al. 2021, Bagheripoor 2018
Cellulose	Wrapped	Yerbamate and carotenoid extract	Butter	Antioxidant and antimicrobial, improve shelf life	Amariei 2020
Pectin and xanthan gum	Dipped	Nisin or sodium lactate	Turkey poached	Reduces the bacterial growth	Mahcene et al. 2021
Locust bean gum, chitosan,	Dipped or Spread	Oregano oil, oleic acid, and	Vegetable	Antimicrobial, improving shelf	Dubey and

Preparation of edible film

The most commonly used polysaccharides base edible film preparation methods are solvent casting explained as:

Solvent casting

The mostly and generally utilized film preparation method that includes spreading of water or water and ethanol solution or dispersion on reasonable surface, drying or evaporation by infrared drying chamber or dry air in a ventilated oven for few minutes that may depend on nature of material (Costa et al., 2018). After drying skinned the film from surface. Film structure depends on the factors, speedy drying and arrangement of casting, wet casting wideness, relative humidity & heat. Fast drying must be evaded owing to decrease the solvent concentration rapidly and consequently regulate the polymer chain movement and intermolecular interaction of casting solution improve (Zuhal et al., 2018). The brief production process of film and coatings is shown in the figure 3.

Extrusion

This extrusion method is depending on the thermoplastic nature of polymers. In this the plasticizer with the high temperature to solution is heated exceeding its glass transition and minimum water. Because the lack of evaporation step and solvent addition this method is mostly used by the commercial purposes. For multilayer film the co-extrusion technique can be used, but due to different characteristics of film components the functionalities may be different (Senturk Parreidt et al., 2018).

Preparation of coatings

Food products are usually coated with polysaccharides base edible coating includes spraying and coating methods etc. On the food surface it creates a tinny film which role as semipermeable membrane that regulates humidity damage and air movement etc. Since the dipping process necessitates an adequate forming solution in the tank, brushing is preferable for small-sized food packaging (Hossain et al., 2021). The dipping approach is ideal if the shape of the food product is irregular. It will easily coat the entire surface of the food. When a homogeneous and thin coating on the food is required, the spraying method is performed. These different coating methods are discussed as:

Dipping

It comprises of following steps: firstly sample dipping into the alginate or any other polymer dispersions, extracting out the sample and draining the extra solution. Next dipping of this sample is into the crosslinking bath to complete development of gel (Galus et al., 2020). This method is of short time that's why solution wastage is negligible during the process. Normally the time of draining and dipping lies between 30s to 5 min (Venkatachalam and Lekjing, 2020). The key benefit of this technique is its full coating uniformly round the complex and coarse surface. This method is mostly used in foods with cut surfaces. In this type many layer by layer or a single layers method is utilized to reduce the penetrating trouble of the coating on the hydrophilic food surfaces (Wang et al., 2021). In the dipping of food items by coating diverse solutions that carries different polyelectrolytes to complete the physio-chemical attachment. At this time, this method is mainly applied on vegetable and fruits (Senturk Parreidt et al., 2018).

Spraying

This is also a commonly utilized technique to prepare semipermeable membrane on the surface of food item. This system prepares and allocates the coating droplets with the aid of nozzle c on the directed food area (Petkoska et al., 2021). This method requires a smaller quantity of coating material due to good exposure and high pressure of spraying approximately 60–80 psi (Molina et al., 2020). In this method coating is uniform, maintain the solution temperature and opportunity to apply several layer, avoid the contamination in coating solution and facilitating to be employed at great surface areas. The solution used for spraying carries low viscosity. Spray flow characteristics depends on, liquid characteristics such as viscous nature, functioning condition (air pressure and flow rate), surface tension and system conditions. Zhang et al. in (2021) sprayed the dispersion of a gelling agent with a water soluble algin on freshly slaughtered hanging animal carcass(Wang et al., 2021). Researcher Galus et al. (2020) studied the thickness of the solution by means of critical application vertically and has smooth sticking in the films of alginates (Díaz-Montes et al., 2021; Zuhal et al., 2021). Syarifuddin et al. (2019) also proposed a different spraying technique, in this the slices of food were firstly dipped in $CaCl_2$solutions, ensuring dryness of polymer solution sprayed on surface of food according to the nature of product (Costa et al., 2018).

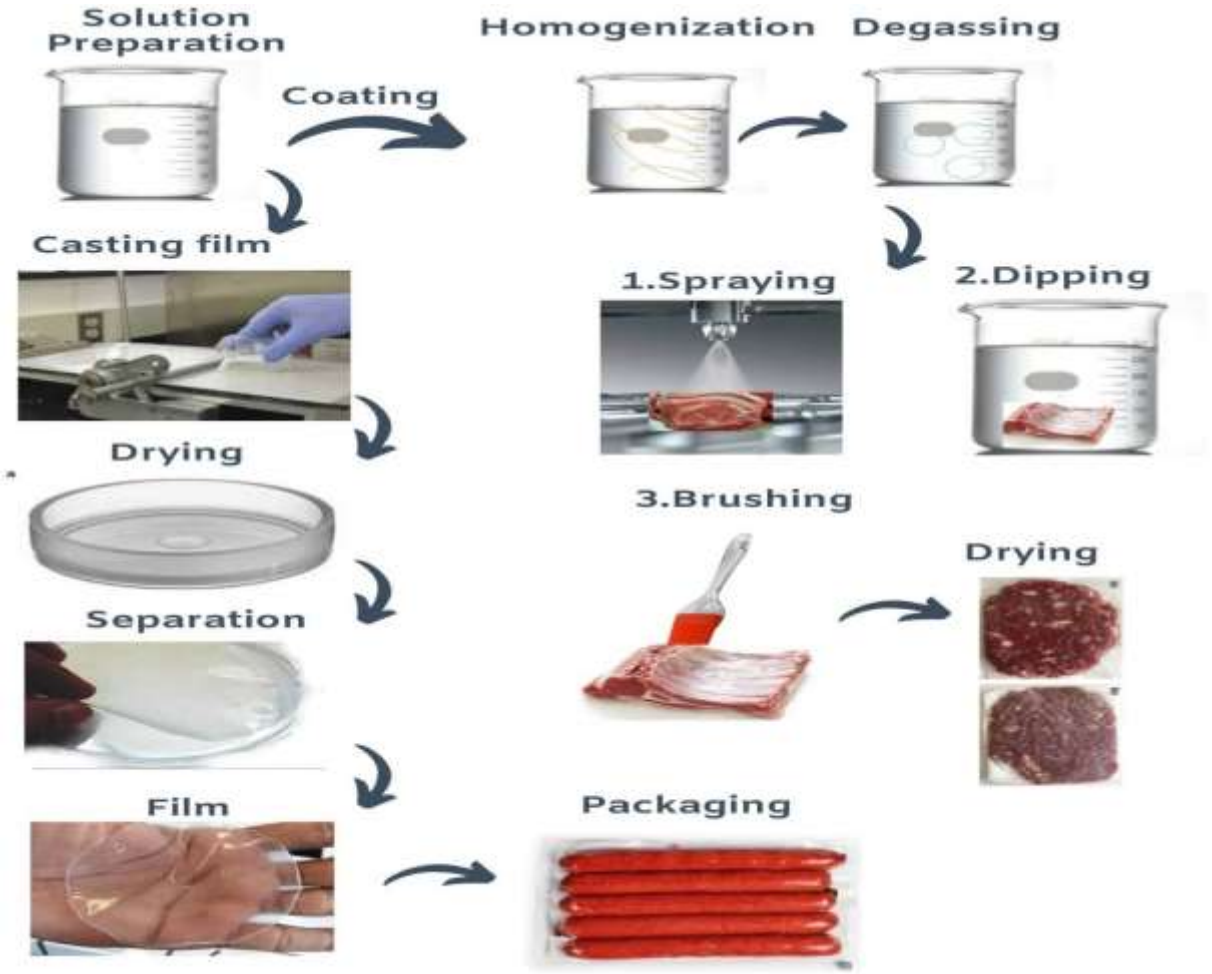

Figure 3. Basic steps in preparation of edible film and coatings.

Vacuum Impregnation (VI)

In this technique the addition of vitamin and mineral in food item. Current researches are creating denser, additional active arrangement of film and air holding in the spongy conditions i.e. vegetables. This technique comprises of similar draining and dipping phases that are described in dipping division. On the other hand, in the case to replace the dipping containers, the food product is immersed into double hermetically sealed vacuum chamber linked with vacuum impels (Pelissari *et al*., 2019). Following to the vacuum chamber, food item is exposed to atmospheric condition but they continue dipped in vacuum (Zhang et al., 2021).

Characterization of edible coating and film

In common the physical characteristics of different biopolymer coating and films are influenced by the characteristics of the key elements. Regarding the multi-component preparations, chemical structure and miscibility of all ingredients are important and affect most physical characteristics of biopolymers materials (Petkoska *et al*., 2021). The most common measured physical characteristics are water vapour permeability and mechanical resistance (Young's modulus, flexibility or tensile strength and elongation at break). The effects of water vapour permeability and mechanical characteristics for particular biopolymer films and coating material are presented in tables 3, respectively. Regarding water vapour permeability study, the most important parameters are relative humidity and temperature (Zuhal *et al*., 2018).

Table 3. Characterization of different material used in edible coating and films.

Polysaccharides	Mechanical characters		Physical characters			References
	Tensile strength (MPa)	Elongation at break (MPa)	T (^{o}C)	RH (%)	WVP(gm^{-1},Pa^{-1})	
Starch	2.10-6.30	42-149	25	0-70	16.1-18.7	Phinainitisatra2021
Chitosan	74.0	4.60	25	30-100	34.5	Diaz-Montes *et al.* 2021
Methylcellulose	69.0	10	25	0-52	8.7-14.0	Subroto *et al.* 2021
Pectin	1.20-2.90	20-51	25	0-100	16.5-20.0	Mihalca *et al.* 2021
Gum	0.002-0.046	0.74-4.60	25	-	-	Hamed *et al.* 2022

Edible packaging can contain a variety of ingredients that are gradually released into the food, enhancing its chemical & physical qualities. The anti-oxidant and antimicrobials both shoe the highly helpful components, when they are incorporated in the coating & films, let for the extension of food life as well as protection from detrimental effects such as oxidation, rancidity, degradation, and discoloration. (Zuhal and Kerse, 2021; Marales-Jimenez *et al*., 2020). Furthermore, nutrients, colorants and flavours may utilized as acting component to improve the quality of food in form of mineral & vitamin, as well as the taste and appearance of food item (Zhang et al., 2021).

Development of active edible packaging

Active edible packaging is utilized to maintain the food quality value, physical appearance, avoid oxidation and unwanted flavor to the product. This system is

designed to "deliberately incorporate components that would absorb or release substances from or into the packaged food or the surrounding environment of food" (Bagheripoor *et al*., 2018). When food products are stored by active packaging system, the chemical, physical, and biological activities of system alter the condition of food leading to an increase in its shelf life without affecting its quality (Petkoska *et al*., 2021; Kumar *et al*., 2021).

When active ingredients are added to polysaccharides, they become active packaging that interacts to the food plus the atmosphere, extending the lifetime of the meat product. Because edible films (i.e. alginate) are translucent, the customer can see the colour and quality of the meat (Hamed *et al*., 2022). In comparison to put attractive food-related graphics on the package, it is also an important component because buyers can view the product they will buy. According to studies, packaging transparency has an impact on customer purchasing decisions and bulk purchases. Plantago seed mucilage or Anethum graveolens with a polymer (Perez-Vergara *et al*., 2020), a significant reduction in the development of microorganisms attained in storage of eighteen days by means of the active coating, while the lifespan of controlled samples was six days. Similarly, a gelatin-based coating with chitosan was also effective to increase the microbial stability of beef samples from 8 to 14 days at 4°C (Petkoska *et al*., 2021).

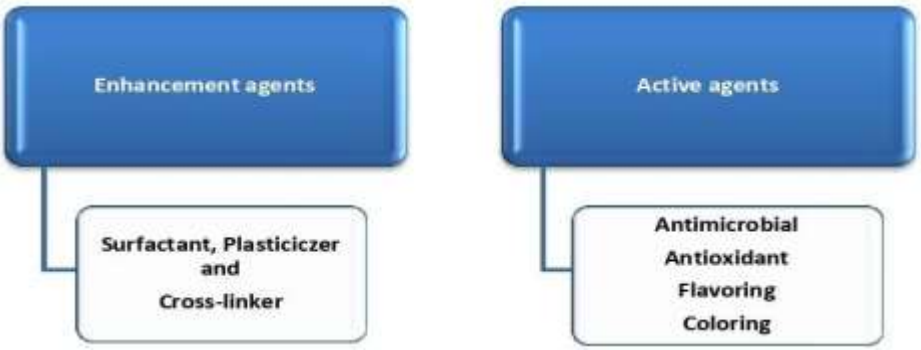

Figure 4. Additives used in edible coating and films.

Additive in edible packaging

Food-grade additives are commonly recognized as safe (GRAS) used in nanoforms or nanoparticles inedible film and coating, also named as "nanoadditives" (Umaraw et al., 2020). The nutritional, organoleptic, functional and mechanical features of the edible coating & film can be improved by integration of several natural or chemical additives discussed following.

Plasticizer

The operational quality of ecofriendly packaging could be enhanced by the addition of non-volatile and miscible plasticizer with polymer. The main objects are to decrease the inter-molecular brittleness and force, increase the extra volume or molecular motion of polymers, create elasticity, controlling coating material flow and improving tear impact resistance (Umaraw et al., 2020). To prevent plasticizer or polymer split-up during application plasticizer must meet the parameters as that of polymer, also having a high boiling point, capacity to modify the mechanical and physical features (Ribeiro et al.,

2021).

Plasticizer nature and amount are significant for the edible packaging formation and designing. The active agent quantity should be amid between 10-26% as minor quantity creates unstability whereas if increase the quantity it cause adhesiveness (Song et al., 2021). Sorbitol that is hard in nature, in comparison with sodium lactate and glycerin that cause strong and highly maintain flexible film. The properties of glycerol and sorbitol is compared by adding to edible films in relation to add the mechanical properties and resulted porosity and vapor contents of film decreased (Hamed et al., 2022; Petkoska et al., 2021). Furthermore, the addition of glycerol caused higher oxygen permeability and water vapour permeability, while barrier properties can't be changed by sorbitol.In the same way, (Jeevahan and Chandrasekaran, 2019) examined mechanical and water vapor permeability properties of different plasticizers on calcium alginate film at different moisture levels. In result, they improved the films water vapor permeability and tensile strength. Many researchers used glycerol as a plasticizer; while their quantity may vary in different condition. Hamed et al. (2022) also determines coating formulation and optimization quantity as 1.16% (w/v). Furthermore, Cruz-Diaz et al. (2019) states the water permeability reduced if glycerol concentration exceeds 1.5% (w/v).

Antimicrobial

By adding antimicrobial agents to edible film and coatings, it is possible to release the agents gradually and maintain the safety for longer period of time compared with their direct addition to food products (Umaraw et al., 2020). As opposed to antimicrobials escaping from coatings, the directly addition to food will immediately reduce microbes counts, but damaged cells recovery and slow growth of undestroyed cells will result in quality losses Wang et al. (2021) treated the castor oil in alginate based edible films carries inhibitory effect against the Escherichia. coli, Staphylococcus and Salmonella, also noted that by increasing concentration of oil inhibitory effect also increased because of hydroxyl group of oil.

Table 4. Brief description of novel agents used in edible packaging.

Material name	Active agent	Product	References
Blood orange peelpectin	Glycerol, sorbitol, andoil corn	Cheese	Amariei 2020
Pectin	nanoclay, carum copticum, β-caroten,essential oil,	Butter	Mahcene et al., 2021
Pectin, fish gelatin	Ginger emprit oleoresin, olive phenolic compound	Beef	Syarifuddin 2019, Subroto et al. 2021
Polylactic acid	Ginger emprit oleoresin	Minced beef	Hamed *et al*. 2020
Chitosan	Sorbitol	Lamb meat	Pelissari et al. 2019
Cellulose	Cloves essential oil, cinnamon	Cooked sausages	Venkatachalam and Lekjing 2020
Alginate	ascorbic acid	Beef steaks	Umaraw *et al*. 2020
Carrageenan	Furcellaran, cinnamon and oregano oil	Chicken breast	Phinainitisatra and Harnkarnsujarit 2021

Antioxidant

According to FDA as the element/ substance are utilized in preservation of food against rancidity and oxidation. Free radical mechanism in auto oxidation in which the free radicals react with unsaturated fatty acids. In addition to autoxidation, lipid quality deterioration can rise from photo-oxidative conditions, oxidation by the lipoxygenase or by the effect of high temperature (Phinainitisatra and Harnkarnsujarit, 2021). Coatings can assist as carriers of anti-oxidative substances to avoid degradation, discoloration, and oxidative rancidity. Hamed *et al*. (2022) studied the antioxidative action of anthocyanin substance attained from blackberry and phenolic compound from coconut oil showed the greatest antioxidant activity in the edible coating and films.

Surfactant

Surfactants are surface active agent and key elements improve wettability and create adhesion in coating material. Due to their low and free energy surfaces, hydrophobic, rough surfaces can be very difficult to adhere to and obtain an edible coating. Furthermore, decreasing surface water activity, Surfactant can reduce the moisture content with emulsifiers when added in coating formulation. A major characteristic of surfactants is that they are present at the liquid-air, solid-liquid and liquid-liquid interfaces with high amount than liquid in bulk form (Kumar *et al*., 2021).

Flavoring or coloring agent

Coated food can be upgraded by improving their organoleptic properties by addition of some elements including coloring agents, sweeteners, and seasonings in the coating medium. The edible coating and films contain numerous nutritional additives i.e. minerals, vitamins and probiotics without affecting the product's quality or reliability (Ribeiro *et al*., 2021). Lipids (especially sunflower oil) widely added to polysaccharide-based coating and film formulas and have improved the water resistant properties. While improving the water resistance and consuming vegetable oil also has some health benefits. Film and coating of low-fat cheese with Mandarin fiber with prebiotic properties increase its nutritional value (Costa *et al.*, 2018).

Application of edible packaging

Dairy and meat products are perishable foods that require adequate processing and handling and refrigeration, to prolong their shelf life. Under the impact of composition, air, light, and processing temperature, chemical deterioration, principally lipid and protein oxidation occurs (Wang *et al*., 2021). Microorganism growth and proliferation in dairy and meat products results in physical, chemical, and sensory change. As a result, application of edible packaging might prevent or limit deterioration processes has emerged as a reasonable methodology to green preservation Meat and meat products.

Meat and meat products

Meat, seafood, and poultry products are protected with edible film and coatings. As these foods are perishable, contain a lot of water. Meat and meat products can be preserved by rounding the coating or film wrapping on it, which prevent discoloration, oxidation, off flavour, shrinkage and perform as antimicrobial (Petkoska

et al., 2021). The coating around meat product inhibits shrinkage, microbial growth, and prevents oxidation and discoloration in meat. The packaging diagram is also shown in fig 5. The variety of edible biopolymers is utilized to coating meat products (Dubey and Dubey *et al*., 2020). Polysaccharides based polymer including sodium alginate derived from brown alga has best film developing properties, excellent antioxidant and hydrophilic in nature. To control the respiration in vegetables and fruits alginate films were utilized initially, later on they are applied for the coating of meat products. This edible film, when combined with active and antimicrobial agents, helps to extend the shelf life of meat products (Phinainitisatra and Harnkarnsujarit, 2021). Alginate has been designated as a generally recognized as safe (GRAS) by the USFDA, used in meat, fish and breast meat of chicken that improve the water barrier properties (Díaz-Montes *et al*., 2021). As active agents, calcium chloride and micro-fibrillated cellulose improved the mechanical properties of the film. Essential oils such as oregano and rosemary areused as antimicrobial agents in meat products to inhibit the growth of microorganisms such *as E. coli, Enterobacteriaceae*. As an alternative for conventional non-biodegradable polymer film and represents the food packaging industry's future (Zhang *et al*., 2021). For packaging chicken breast meat, an alginate based edible film with black cumin oil used as an antimicrobial agent is used.When stored at 40°C, this film inhibits the *Escherichia coli* growth and change the colour of meat for about five days (Amariei, 2020). A packaging diagram in edible film is explained below in fig 5. Studies demonstrate that using gelatin and alginate film with oregano essential oil as an antibacterial agent for fish fillet packaging inhibited bacterial growth by 15 days (Galus *et al*., 2020). *Salmonella typhimurium* growth is inhibited by sodium alginate film with additional cinnamon, oregano, and savoury oil (Jeevahan and Chandrasekaran, 2019). Meat food is highly perishable and has a short shelf life. As the surrounding environment becomes contaminated during transit and storage, resulting in foodborne diseases and a change in the quality and nutritional content of items, that decreases food demand among consumers (Diaz-Montes *et al*., 2018).

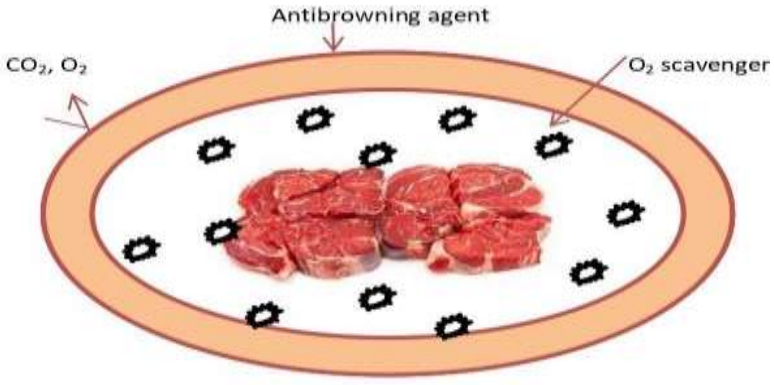

Figure 5. Packaging diagram in edible film.

An-other remarkable outcome stated for the usage of chitosan with Zataria multiflora EO (Hossain *et al*., 2021) This investigation explained that chicken breast can be store at

4°C for 20 days due to significant reduction of both total (viable and psychotropic) and selected (Enterobacteriacea, pseudomonas spp., *LAB* and yeasts or molds) microbial growth for the duration of storage, which significantly increase life period of food item.

The antimicrobial agents to catfish-based gelatin slow microbiological development and increase the life of fresh white shrimp for ten days. Fresh rainbow trout fish with a gelatin coating with cinnamon that act as antimicrobial agents are less likely to develop bacteria and have a longer shelf life (Hamed *et al*., 2022).

Dairy products

Cheese, yogurt, milk all are dairy products and consumed on a daily basis. Cheese is primarily composed of proteins, vitamins, and fats. The ripening process, reduce transfer of mass and preservation are achieved by applying edible packaging over the dairy products. (Amariei *et al*., 2020). Edible film coating techniques used should completely preserve the food and extend its life. Because the dipping process necessitates adequate solution preparation in tank, for lower sized cheese brushing technique is preferably used (Ribeiro *et al*., 2021). If the cheese shape is not regular the dipping technique is used that cover the all surface area of product. When a homogeneous and thin coating on the cheese is needed, the spraying method is performed. Electrostatic spraying increases efficiency while lowering coating solution waste. The edible films are made by casting and then covered round the cheese such that the film completely covers the cheese. Films and coatings establish a barrier between the cheese and the environment, extending the shelf life of the cheese (Phinainitisatra and Harnkarnsujarit, 2021).

Comparatively the edible films produced from whey protein have greater barrier qualities. When polysaccharide is mixed with additives such as glycerol,a plasticizer, and pH adjustment agents in a film-forming solution is made by means of the solvent. Following that, the films are dried in a heated oven at roughly 35°C for 18°C hours, and cheese slices can be pack in between them. Films prepared by alginates are transparent allowing the consumer to see the cheese's quality (Díaz-Montes *et al*., 2021), containing antimicrobial agents. Bacteria and yeast will be inhibited by these agents. Each antimicrobial agent is designed to kill the microbe. Against penicillium, and lysozyme against E. coli and for mould and yeast lactic acid is used. Cheese's susceptibility to react with oxygen is reduced by antioxidant compounds. When cheese reacts with oxygen, it changes colour and flavour (Hamed *et al*., 2022). Mihalca *et al.* (2021) studied the sodium alginate and chitosan with different coating materials, their result proves that alginate based coting as the best quality and wettability properties. Edible packaging by chitosan whey protein carries ricotta cheese at 4°C. Even after 21 days, the quantity of mesophilic and psychotropic bacteria was significantly reduced, and cheese maintain its good condition (Bagheripoor *et al*., 2018). Staphylococcus spp., Enterobacteriaceae, yeast, and mould can't produce considerably after 60 days of storage at 4°C when polysaccharide polymer containing antimicrobials such as natamycin and lactic acid were utilized for packing of semi-hard bovine cheese (Kumar *et al*., 2021). High fat dairy products like butter which causes of oxidation and shortens its life, edible coating of corn starch enriched with ginger oil, stored at 2–5 °C,

or corn starch-based edible coating adding ginger oil as an active component inhibits the oxidation of fat (Song *et al*., 2021). As of the development of microbe on the food surface, paneer has a short shelf life. Cinnamon essential oil, used as an antibacterial agent in the edible coating medium of sodium alginate, helps to keep paneer fresh and extend its shelf life (Mihalca, 2021).

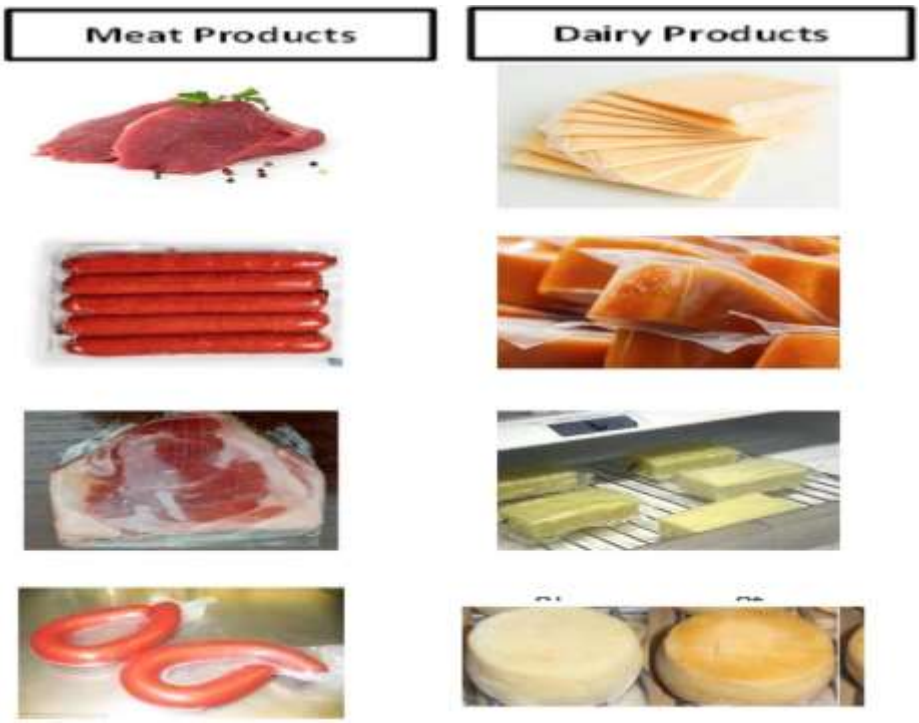

Figure 6. Edible film and coated meat and dairy products available in market.

Conclusion

In this era, a deep study and increasing trend to edible packaging, such as edible coating and film, provides a ray of hope and excellent alternative to the other conventional packaging techniques. An edible film and coatings containing of starch, cellulose, chitin and cellulose etc. have still recorded no toxic effect on humans, are completely biodegradable, safe, prolong the life time of food and maintain the food quality value. The search for new sources of films and coatings, on the other hand, is still ongoing. Commercialization level is forward by the reason of the mechanical properties, barrier limitation and high processing value of the film and coatings. For commercialization more research work is require to fix these issues that solve the high processing cost and the quality value of food edible packaging.

Conflict of Interest

The authors have not declared any conflict of interest.

Authors Contributions

All the authors have contributed equally to the research and compiling the data as well as editing the manuscript.

References

Amariei, S., Norocel, L., & Gutt, G. (2020). New edible packaging material with function in shelf life extension: Applications for the meat and cheese industries. *Foods*, *9*(5), 562. https://doi.org/10.3390/foods9050562

Bagheripoor, N., Khoshgozaran-Abras, S., Sohrabvandi, S., Khorshidian, N., Mortazavian, A. M., MollaKhalili, N., & Jazaeri, S. (2018). Application of active edible coatings to improve the shelf-life of cheese. Food Science and Technology Research, 24(6), 949-962. https://doi.org/10.3136/fstr.24.949 Costa, M. J., Maciel, L. C., Teixeira, J. A., Vicente, A. A., & Cerqueira, M. A. (2018). Use of edible films and coatings in cheese preservation: Opportunities and challenges. Food Research International,107, 84-92. https://doi.org/10.1016/j.foodres.2018.02.013

Díaz-Montes, E., & Castro-Muñoz, R. (2021). Edible films and coatings as food-quality preservers: An overview. Foods, 10(2), 249. https://doi.org/10.3390/foods10020249

Dubey, N. K., & Dubey, R. (2020). Edible films and coatings: An update on recent advances *Biopolymer-based formulations* (pp. 675- 695): Elsevier. https://doi.org/10.1016/B978-0-12-816897- 4.00027-8

Erkmen, O., & Barazi, A. (2018). General Characteristics of Edible Films. Vol. 2 No. 1: 3 Received: January 22, 2018. *Accepted: January, 29*. https://doi.org/10.61535ecdfd7b3d121559900e/11AUA

Galus, S., Arik Kibar, E. A., Gniewosz, M., & Kraśniewska, K. (2020). Novel materials in the preparation of edible films and coatings—A review. *Coatings, 10*(7), 674. https://doi.org/10.3390/coatings10070674

Hossain, A., Skalicky, M., Brestic, M., Mahari, S., Kerry, R. G., Maitra, S., . . . Popov, M. (2021). Application of Nanomaterials to Ensure Quality and Nutritional Safety of Food. *Journal of Nanomaterials, 2021*. https://doi.org/10.1155/2021/9336082

Hamed, I., Jakobsen, A. N., & Lerfall, J. (2022). Sustainable edible packaging systems based on active compounds from food processing byproducts: A review. *Comprehensive Reviews in Food Science and Food Safety*, *21*(1), 198-226. https://doi.org/10.1111/1541-4337.12870
https://www.statista.com/statistics/237632/production-of-meat-worldwide-since-1990

Jeevahan, J., & Chandrasekaran, M. (2019). Nanoedible films for food packaging: A review. *Journal of Materials Science, 54*(19), 12290-12318. http://doi.org/10.1007/s10853-019-03742-y

Kumar, L., Ramakanth, D., Akhila, K., & Gaikwad, K. K. (2021). Edible films and coatings for food packaging applications: a review. *Environmental Chemistry Letters*, 1-26. https://doi.org/10.1007/s10311-021-01339-z

Mahcene, Z., Khelil, A., Hasni, S., Bozkurt, F., Goudjil, M. B., & Tornuk, F. (2021). Home-made cheese preservation using sodium alginate based on edible film incorporating essential oils. *Journal of Food Science and Technology, 58*(6), 2406-2419. https://doi.org/10.1007/s13197-020-04753-3