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Anti-microbial Edible Films and Their Applications to Improve Food Quality and Reduce Environmental Pollution: A Review

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Abstract

In view of modern trends towards protecting the environment of food packaging materials, along with preserving food quality and safety, especially about the use of industrial packaging materials, especially non-degradable plastic materials, and the health and environmental damage resulting from their widespread use. Therefore, the current article included highlighting the preparation of anti-microbial Edible Films from natural biological sources, as many types of bacteria, algae and yeasts can produce biopolymers with properties suitable for food packaging, at the same time they are automatically degradable in the environment. The attention of specialists turned towards Edible Films, a natural, biological alternative that is edible and safe for health, at the same time does not cause environmental pollution. This technique has been applied to different types of fresh and processed foods. There are many natural biological sources for preparing edible films, such as proteins (such as milk proteins, wheat gluten, corn zein, etc.), polysaccharides (starch, pectin, cellulose and its derivatives, chitosan, carrageenan, etc.), lipids such as (waxes and glycerides), or a mixture of these compounds. The manufacture of these membranes provides many desirable properties in food, such as maintaining the moisture of the food, preventing the loss of volatile aromatic flavor compounds, reducing the migration of fats, and prolonging the storage life of the food by inhibiting microbial growth and incorporating substances into the membrane solution such as antimicrobials or antioxidants, and food additives, thus improving the appearance, sensory and nutritional properties of the food product.

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Introduction

Humans have known packaging since ancient times. He used animal skins and tree leaves. With the progress of time, he used pottery, glass, plastic, paper, etc., to preserve food. Packaging is an important part of the food manufacturing process chain for the purpose of preserving food, facilitating the process of transporting and handling it, and maintaining its quality after production and until it arrives to the consumer's table (Regalado *et al.*, 2006). Food packaging systems perform multiple functions, including those related to containment, marketing, and providing food-related information. The primary function is to separate food from the surroundings, reduce exposure to spoilage agents, and avoid loss of desired compounds (oxygen, water vapor, fats, and other flavors) and thus prolong the shelf life of food, Natural polymers, such as wood, cotton, wool, silk, and leather, have been used for centuries. However, it was only after the discovery and development of petroleum-based polymers that these materials, especially plastics, gained widespread popularity throughout the second half of the twentieth century, representing 70% of the total materials used in food packaging, until they dominated the market of food packaging, This is due to their low cost, availability of raw materials, flexibility of use, mechanical resistance, heat resistance, and diversity of their forms. However, these sources are non-renewable and most of them are not subject to natural decomposition in the environment (Álvarez-Hernández *et al*., 2018; Fonseca-García *et al*., 2021).

Many studies have proven that they are harmful to health, especially cancerous tumors (Ciocan-Cartita *et al*., 2020; Sharma *et al.,* 2021). In addition, most of these materials are not degradable or do not decompose easily. It is present in the environment in a large and continuous manner, as thousands of tons of it are released annually into the environment, and there is difficulty in disposing of its waste, (Regalado *et al*., 2006; Baldwin, 2012). In the United States alone, more than 32 million tons of plastic are disposed of annually (Álvarez-Hernández *et al*., 2016), and their recycling is limited due to their high economic cost. In fact, less than 3% of plastic waste worldwide is recycled. Disposing of or burning them also leads to the production of toxic compounds, such as furans and dioxins produced from burning polyvinyl chloride (PVC) (Jayasekara *et al.*, 2005; Fonseca-García *et al*., 2021; Sowmyashree *et al.*, 2021), there are approximately 500 chemicals used in the packaging industry, the most important of which are residues of Vinyl chloride monomer (VCM). Mercury, Lead and Cadmium. It has been scientifically proven that some of these materials have negative effects on human health, such as poisoning and cancer, in addition to the negative impact on the environment Such as Soil pollution by the production of some toxic emissions e.g. dioxin and other toxic residue, the process of disposing of them by burning, for example, results in polluting gases (Mathabe *et al*., 2020; Sowmyashree *et al*., 2021), Therefore, in the last two decades, the food packaging industry has received great attention from those concerned with food health and safety on the one hand and preserving the safety of the environment on the other hand, as they moved towards finding packaging materials that are edible and at the same time biodegradable (Álvarez-Hernández *et al*., 2018; Fonseca-García *et al.*, 2021). In view of the health and environmental damage resulting from the use of industrial packaging materials, especially plastic, the current article therefore aimed to highlight the preparation of anti-microbial Edible Films from natural biological sources with properties suitable for food packaging and at the same time environmentally friendly in addition to its appearance, health and nutritional value and prolonging its shelf life.

Bio-Packaging

The use of natural biopolymers to preserve food goes back centuries to the time of Egyptian civilization. The use of wax has been known since the twelfth century in China, where it was used to coat fresh fruits and vegetables to prevent moisture loss and maintain their texture and appearance during storage (Jooyandeh, 2011; Mathabe *et al*., 2020). Paraffin was also used for the first time in 1950 in the

United States of America (Kokoszka and Lenart, 2007). Gelatin and resins have also been used since 1990 (Valencia-Chamorro *et al*., 2009), after which plastic materials were discovered, which are derived from petrochemicals and have been widely used in food packaging and packaging (Regalado *et al.,* 2006). The rapid progress and development of technology have created more options, including natural biofilms (Krochta, 2002; Sharma *et al.,* 2021; Sarker and Grift, 2021). There are many natural sources for preparing edible films from plant, animal, and microbial sources, and they include proteins, polysaccharides, fats, or A mixture of these materials to produce what is known as composite films, as the technology of preparing or manufacturing Edible films is considered an environmentally friendly technology that aims to ensure food safety and quality in addition to its appearance, health and nutritional value and prolonging its shelf life. These systems are also used to reduce moisture transfer, reduce fat migration, and improve their mechanical properties to facilitate the process of circulation, with possible use as carrier systems for active substances known as active packaging, such as those combined with antimicrobial agents or antioxidants, flavor and color substances, food supplements (Campos *et al.,* 2011; Ramos *et al.,* 2012).

Edible Films

Global interest in the manufacture of edible films or covers has increased due to the growing concern over the frequent use of manufactured packaging materials and their harmful effects on health, in addition to their environmental pollution because they are not biodegradable (Hong and Chen, 2017). These films have the advantage of being able to be eaten with the product and its effective contribution to reducing environmental pollution has many advantages, the most important of which is its ability to trap or impede the transfer of moisture, gases, and aromatic flavor compounds from foods, thus preserving the quality of the food and increasing its shelf life. It also provides protection from mechanical damage, improving the mechanical handling properties of foods. (Krochta, 2002; Souza *et al*., 2013 Szabo *et al*., 2021 Mathabe *et al*., 2020). In addition to its importance as a carrier of many effective additives such as antimicrobials, antioxidants, color and flavor materials, etc. Therefore, we notice the development of the technique of edible films that has begun to attract the attention of research centers in the fields of chemistry, physics and biotechnology because of the wide applications that can be applied and benefited from for the use of natural polymers (Sharma *et al* ., 2021; Sarker and Grift, 2021).These films can also improve the appearance of food by providing them in different, attractive shapes and colors, making them more attractive to the consumer (Sowmyashree *et al.,* 2021). They also work to enhance the nutritional value, such as films made from proteins such as casein, whey proteins, and wheat gluten, because they are considered a source of essential amino acids. (Bourtoom, 2009) Edible Films can be defined as a thin, cohesive film or sheet formed from a natural biopolymer and its thickness ranges between 0.050-0.250 mm (Jooyandeh, 2011).

Many modern technologies have appeared in the packaging industry, such as the use of Active Packaging, or what is known as Effective Packaging, by introducing natural active materials that are integrated with membranes or within the packaging system instead of industrial preservatives or antioxidants to achieve the active packaging function to maintain the quality of the product and increase its shelf life in addition to the previously known properties of natural edible biofilms, antimicrobial packaging technologies have also been used for food packaging (Bhat and Bhat, 2011; Singh *et al.*, 2014) and the use of nano technologies (Punia *et al.*, 2021) There is also an Intelligent and clever packaging system, which is an advanced effective packaging system that provides additional functions, as it monitors the condition of the packaged food to provide information related to the quality of the food item during transportation and storage, such as it containing indicators that sense or detect changes that take place in the food, as it provides information about microbial changes or Chemicals that occur in food during storage (Kerry *et al.*, 2006; Scetar and Kurek, 2010) Currently, a barcode biosensor has been discovered, which is being developed to detect microbial pathogens in food through the interaction between these pathogens and the sensor by giving a signal called Toxin Guard (Bhat and Bhat, 2011).

Types of edible films according to the nature of the materials used in their preparation:

- **Protein Films**

Proteins are suitable biopolymers in the manufacture of edible films, with excellent mechanical properties, and a good ability to retain gases, reduce fat migration, and enhance nutritional value because they are a source of essential amino acids and are naturally antimicrobial, such as whey proteins, in addition to being with the requirements of environmental protection due to their ability to decompose in the environment, therefore. These sources are called environmentally friendly coatings or films, and their sources differ in terms of the number and type of amino acids that make up them and their sequence, which have a role in forming bonds between molecules and thus the efficiency of the manufactured membrane (Baldwin, 2007). Among the functions of edible membranes manufactured from proteins is addition to reducing pollution Environment (Bourtoom, 2009; Sharma *et al.*, 2019; Mathabe *et al*., 2021; Sowmyashree *et al*., 2021) In terms of mechanical properties, films made from proteins are superior to the types of films made from polymers of sugars and fats. This is because proteins are characterized by a unique structure, as they contain 20 different monomers, which gives a wide range of functional properties (Punia *et al*., 2021). Many protein sources have been used in the manufacture of Edible films, including:

Animal proteins: These include milk proteins, collagen, and gelatin. Edible milk protein films have been used since 1995 for their important roles in helping food manufacturers, as they are used as a protective layer on foods or between food components, where they control and prevent the transfer of moisture and drying of products. It controls the migration of components into food systems in addition to providing mechanical protection to protect and protect the integrity of the packaging (Skurtys *et al*., 2010).

Plant Proteins: It is receiving increased attention at the present time in the manufacture of edible films, examples of which are corn Zien, wheat gluten, and soya protein. Edible films from vegetable protein sources are used by immersion or spraying on the surfaces of fresh fruits and vegetables to extend their shelf life and their nutritional and marketing value, Edible films have been developed from soy protein, which is used to wrap foods such as sweets and French fries. The importance of these films or covers lies in using natural sources and avoiding industrial ones in order to preserve the environment as they are biodegradable and edible (Sessa *et al*., 2007).

- **Polysaccharide films**

Many polysaccharides and their derivatives are used in the preparation of edible films, as they are considered natural biological materials spread in the plant kingdom. They are also found in the composition of insect bodies and include starch, pectin, alginate, carrageenan, chitosan, gum, cellulose, and their derivatives (Han and Gennadios, 2005; Sharma *et al*., 2019; Sarker and Grift, 2021; Bangar *et al*., 2021) They are used in the production of edible films because they are vital sources that are widely available in nature and are cheap in price, as well as their ability to be renewed and have the ability to form edible films with good mechanical properties to preserve the flavor and texture and prolong the storage life of the food due to their hydrophilic nature (Ma *et al*., 2008). It also has good gases-retaining properties, flavoring materials, and fats due to its ability to form a cross-linking network between polymer chains using hydrogen bonds, while it is considered a weak barrier to water vapor due to its hydrophilic nature. It is also characterized by being tasteless, colorless, odorless, non-toxic, and antimicrobial by retarding microbial growth due to Reducing water activity and increasing amylose, which is one of the components of starch responsible for increasing membrane flexibility, produces a membrane with good preservation qualities for oxygen and fats and high water solubility (Romero-Bastida *et al.*, 2005; Dhanapal *et al*., 2012; Lauer and Smith, 2020).

Methyl cellulose derivatives, Carboxy methylcellulose CMC, Methylcellulose MC, and Hydroxpropyl cellulose, are used in preparing edible films because they have barrier and mechanical properties to develop properties. As for Chitosan, it is a high molecular weight sugar extracted from crustaceans and is widely found in nature. It is non-toxic and has good properties which are anti-microbial, poorly soluble in solutions, and very sticky, similar to glue. The membranes made from them are characterized by cohesion and resistance to the transfer of gases and fats, while their permeability to water vapor is considered limited. Chitosan films have been used to wrap mango slices and strawberries to prolong their shelf life. It can be an ideal edible film for preserving fresh fruits and foods due to its excellent biochemical properties. The chitosan film reduces the decomposition of the skin of strawberries and raspberries and thus prevents the activity of the glucanase enzyme on these fruits compared to uncoated fruits (Leceta *et al*., 2013; Sharma *et al*., 2019; Sarker and Grift, 2021).

Lipids films

Lipids are recently used as edible films for many food products, such as meat, seafood, vegetables, fruits, grains, and frozen foods. There are many fatty compounds, animal and vegetable fats such as Cotton seed oil, corn oil, soybean oil, olive oil, fish oil, and flax oil and waxes such as paraffin wax, beeswax, carnauba wax, and others in the preparation of edible films because of their high ability to retain moisture because they are materials. Hydrophobic, especially fresh foods. In addition to giving them a good appearance and shine, as well as increasing the gloss and maintaining their external appearance, especially in preserving the shine of fruits, especially when they are to be transported over long distances, waxes are considered one of the most efficient materials in retaining moisture, followed by saturated fatty acids (Sonti, 2003).

Composite Films

Films made from polymers of sugars and proteins are characterized by suitable barrier and mechanical qualities and properties, but they are permeable to moisture and their barrier properties towards water are considered weak, while membranes prepared or manufactured from fats have good barrier properties towards water vapor and their permeability to oxygen is high, and their mechanical resistance is weak. To improve the properties of these membranes, these materials combine together to obtain membranes with appropriate properties (Diab *et al*., 2001).

Edible and antimicrobial films

Filling with antimicrobial agents in the field of manufacturing edible films is one of the very effective methods whose use has spread recently and is striking, as most studies have focused on preparing edible films incorporated with antimicrobial agents to control the growth of microorganisms that cause food damage and food spoilage. And human food poisoning (Sothornvit *et al*., 2005; Erginkaya et *al*., 2014) these films are prepared by adding or incorporating antimicrobial agents into the films, directly or indirectly (Sharma *et al*., 2019; Sarker and Grift, 2021). The use of antimicrobial agents depends on the type and physical properties of the films, the effectiveness of the antimicrobial itself against certain types of microbes, the extent of its interaction with the film matrix, as well as its interaction with food components, whether it is safe and permissible from a health standpoint, its storage conditions, and the type of plasticizer added to the films (Perez-Perez *et al*., 2006). Many organic and inorganic chemicals, metals, alcohols, and ammonium compounds have been used as antimicrobials, but with increasing consumer awareness of the danger of these additives, this has prompted specialists in this field to move towards using antimicrobial agents from biological natural sources in the preparation of edible films, such as bacteriocins such as Nisin, Pediocin, and anti-microbial enzymes agents, especially Lysozyme, herbs or essential oils extracted from them, and others (Dawson *et al*., 2005; Shokri *et al*., 2015; Pilevar *et al*., 2020).

Methods of adding antimicrobial agents to edible films

- They are added in the form of small envelopes or fillings inside the food container, which may contain materials that remove moisture, oxygen scavenging, or generating vapors, or control the growth of microbes (Bhat and Bhat, 2011).
- Antibiotic agents are added by dissolving them within the polymer components, provided that they have the ability to migrate into food. Therefore, they must be in contact with the surface of the food so that they can spread and penetrate inside it.

- Adding antimicrobial agents by coating them on the surface of the polymer if they are sensitive to heat so they cannot be added during the polymer manufacturing process, so they are added by coating them on the surfaces of the polymers after the manufacturing process.
- Loading or binding the Anti-agent into polymers through ions or binding agents the event that active groups exist between the polymer and the counteractive agent.
- Use of a polymer with an antimicrobial nature (Emamifar, 2011).

Types of antimicrobials

- **Chemical antibiotics**

Many organic and inorganic chemicals and minerals have been used as antimicrobials in the preparation of edible films combined with antimicrobial agents, the most important of which are benzoic acid, propionic acid, sorbic acid, benzoate sodium, sorbate potassium, and EDTA. The use of chemical preservatives in various food products means increasing the shelf life, preserving the food product, and preventing the growth of pathological organisms that threaten human health, but they are criticized for their high cost and potential damage to food quality, in addition to the health effects on consumer health (Skurtys *et al.,* 2010).

Natural antibiotics

The use of chemical preservatives in various food products means increasing the shelf life and inhibiting the microbial growth of the food, thus preserving its quality and safety. However, many disadvantages have been noted, such as the high cost, potential damage to food quality, and potential health effects on human health. Therefore, researchers' attention has turned to the use of natural antibiotics (Shokri *et al*., 2015; Pilevar *et al*., 2020). It is also noticed in recent years that consumers have begun to tend to eat everything natural and stay away from artificial preservatives (Mohamed *et al*., 2020; Ferreira *et al*., 2021), the most important of which are:

Bacteriocins

Bacteriocins are considered natural sources of antimicrobials that are used in edible films. They are compounds of a protein nature produced by a specific group of bacteria and have lethal or inhibitory effects on the growth of the target bacteria, which are often genetically related to the bacteria that produce bacteriocins. The most important types of bacteria that produce bacteriocins are the group of lactic acid bacteria (LAB), especially the genus Lactobacillus, where the strain *Lactococcus lactis subsp lactis ITAL 38* produces bacteriocins that are effective in inhibiting gram-positive bacteria such as Staphylococcus aureus Listeria monocytogenes, in addition to the bacteriocins Nisin, Pediocin, and lacticin. These bacteriocins can be made effective in inhibiting Gram-negative bacteria when combined with the chelating agent EDTA (Hanlin, 1993; Dawson *et al*., 2005; Aboul-Anean *et al*., 2013) Bacteriocins have broad inhibitory activity against many types of pathogenic bacteria such as *Pseudomonas aeruginosa, P. fluorescens, Staphylococcus aureus,* , *Escherichia coli* O157:H7, *Salmonella typhi, Listeria monocytogenes*and, *Shigella flexneri*, *Clostridium botulinum* (Darbandi *et al* ., 2022). There are several methods for detecting types of bacteria that produce bacteriocins, including immunological, genetic, and biofluorescence methods, and methods that depend on inhibitory activity, which are the method of diffusion in agar and the method of diffusion in pits (Well diffusion method), (Coventry, 1997).

Essential oils

Medicinal plants are used all over the world in folk medicine, and they are used directly or indirectly, such as their extracts of active substances or their aromatic essential oils, to obtain their health benefits for humans. Secondary metabolites are divided into four main sections, which include flavonoids, terpenes, alkaloids, and others, which are effective substances treats many medical conditions and fights cancer cells (Nirmala, 2011; Bonilla *et al*., 2012). Essential oils extracted from plant sources are added to enhance the functions of edible films. These oils are incorporated into the polymeric matrix of edible films or coatings, adding biologically active compounds and antioxidant, antibacterial, and antifungal properties (Morar *et al*., 2017; Socaciu *et al*., 2018; Yousuf *et al*., 2021) Essential oils can be defined as aromatic oily liquids obtained from plant materials that can be used in edible packaging applications to enhance antimicrobial activities (Nansombat and Wimuttigosol, 2011). These oils play an important role in antimicrobial activities due to their high content of phenols and terpenes (Burt, 2004). The inclusion of essential oils in edible packaging is considered a recent trend in active packaging systems (Carpena, *et al*., 2021). These packaging systems provide microbial safety, extend the shelf life of packaged foods, and achieve avoidance of artificial preservatives (Souza *et al*., 2013; Szabo *et al*., 2021), which prompted researchers to turn towards plant sources and their essential oils as antimicrobial agents (Alwhibi and Soliman, 2014). The synergistic effects between essential oils and their components can enhance the functional properties of edible films and thus increase the shelf life of foods, especially foods containing a high percentage of fat. It is worth noting that the use of some oils may cause some cases of poisoning or an undesirable odor and change the sensory properties of the food product (Sánchez-González *et al*., 2011) Therefore, scientific controls must be used and followed in the use of medicinal herbs or their oils, and one must avoid the indiscriminate use of these plants (Al-Haddad, 2021).

Antimicrobial enzymes

Antimicrobial enzymes are widely distributed in the environment and play an important role in inhibiting the growth of microorganisms, especially bacteria and fungi (Thallinger *et al.*, 2014). Recently, they have received clear attention as new and unique agents in food preservation (Seifu *et al.*, 2005), where they can extend the shelf life of food by preventing the growth of spoilage microbes through several mechanisms, including reducing the nutrients needed for the growth of microbes, producing germ-resistant substances, damaging the cell wall, or disabling a specific vital enzyme in microorganisms (James *et al*., 1996). In this regard, there are many antimicrobial enzymes, the most important of which are:

Lysozyme

It is Peptidoglycan N-acetylmuramoyl hydrolases, also called Muramidases. Lysozyme is one of the most important antimicrobial agents used with edible films. Egg whites are considered a rich source of Lysozyme, as one egg contains about 0.3-0.4. Lysozyme attacks the 4-1 $\mathcal{B}$-binding

The units link the secondary units N-(G) acetylocoseamne and N-acetylmuramic acid (M), which make up the peptedoglycan chains of the bacterial cell wall, which leads to the degradation of the cell wall. It showed very high effectiveness against inhibiting the growth of gram-positive bacteria, and when combined with EDTA, it becomes effective against gram-negative bacteria (Juneja *et al*., 2012; Jooyandeh *et al*., 2011).

Lactoperoxidase

It is one of the most abundant natural enzymes in milk and has antimicrobial activity against gram-positive bacterial species and is antifungal and antiviral (Elliot *et al*., 2004). Other antimicrobial enzymes used in the manufacture of edible films include Glucoseoxidase and Chitinase, which have properties antimicrobial, in addition to being antioxidants (Krasniewska and Gniewosz, 2012).

The mechanism of the anti-microbial films action

Protecting food from microbial contamination of food is one of the most important requirements of packaging operations with edible films, Many experiments have been conducted to improve the quality of food products and delay their spoilage by supplementing the packaging with antimicrobials, as antimicrobials with the coated materials reduce the growth rates of microbes and thus prolong their preservation period and maintain their preservation. Food quality and safety (Quintavalla and Vicini, 2002). The addition of the antimicrobial substance depends on the type and characteristics of the membrane, the effectiveness of the substance used in preparing the membrane, the extent of its interaction with the membrane matrix, as well as its spread and interaction with food components, and whether it is safe from a health standpoint(Perez-Perez *et al.,* 2006).

Antimicrobial agents work by inhibiting the growth of microbes by destroying the bacterial cell membrane and changing the permeability of the cell wall. The cell membrane of bacteria impedes the process of synthesis of nucleic acids in bacteria, and the leakage of cell content, which leads to the dissolution and death of bacteria (Fuster *et al*., 2020; Hao *et al*., 2020). Antimicrobial agents are added to packaging directly or indirectly, which provides the food product with an additional barrier against microbes (Skudlarek, 2012). Antimicrobial agents can be added in the form of packaging that contains substances that generate vapors, remove moisture, or oxygen scavenging to inhibit the growth of bacteria and fungi (Bhat and Bhat, 2011), or they may be combined. By dissolving it within the components of the polymer used in preparing the cover (Emamifar, 2011).

Mechanical properties of the edible films

Mechanical properties are among the most important properties of edible films because they are an indicator of the durability and cohesion of the films. They depend on the type of material composing the film and on its structural cohesion in particular to enhance the mechanical safety of the food during manufacturing, handling and transportation (Adedeji *et al.,* 2009).

The mechanical properties of membranes include the tensile strength of the membrane, which is defined as the maximum force exerted on the membrane per unit cross-sectional area before the membrane is cut, and elongation, which represents the distance by which the membrane expands before it is cut, divided by the length of the membrane. Resiliency is the opposite of hardness and is estimated. By multiplying the tensile strength by the elongation, it is one of the important measures for expressing the flexibility and strength of membranes. Types of polymeric materials differ in their resistance to the conditions of transport, handling and transportation of food products (Jooyandeh, 2011). The pH and plasticizers have an effect on the mechanical and barrier properties of the membrane. When using whey protein isolate in the preparation of edible films, increasing the pH and increasing the concentration of the plasticizer improved the tensile, elongation, and solubility properties, but it caused an increase in water vapor permeability. Also, increasing the plasticizer concentration with the stability of the plasticizer. PH led to a decrease in tension and an increase in elongation and solubility of the membranes, and there was no effect on the permeability to water vapor (Kandasamy *et al.,* 2021).

Conclusions

Industrial chemicals have become an important part of our lives due to their wide applications in food packaging and food preservation. However, they are considered one of the most important causes of cases of food poisoning, allergies, etc. They are also considered one of the most important causes of environmental pollution because they are not decomposed in nature, the need has emerged to use packaging materials from natural, antimicrobial, and environmentally friendly sources to reduce the use of industrial chemicals, as natural sources are effective materials in preserving food. It is biodegradable and renewable and is used to improve the overall quality of food products, as well as being edible and prolonging the storage life of food. It also works to improve the economic efficiency of packaging materials، therefore, many research centers have moved towards using natural polymers from their various sources, namely proteins, polysaccharides, and fats, due to their suitable properties to prepare films with properties suitable for packaging the food product and the technology of manufacturing edible films can be applied on different types of fresh and processed foods.

Conflicts of interest

The authors declare that they have no conflict of interest.

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