INNOVATION IN FOOD PACKAGING: EDIBLE FILMS

1. ABSTRACT

In recent years, edible films are thriving because they exhibit a wide variety of benefits, including the use of edible packaging material over synthetic films. Edible films are environmentally friendly, but environmental pollution is not caused by them. Compared to non-environment-friendly packaging materials, edible films exhibit functions such as barrier properties, thus enhancing the recyclability of packaging materials. Scientists have obtained and characterised new materials from agricultural processing, which are generally considered waste materials. The aim of this analysis is to present the edible films and coatings in a succinct manner by explaining the relevant materials, their properties and their applications.

2. INTRODUCTION

Organoleptic, nutritional and hygienic factors decide the quality of food, but these are transformed during storage and commercialization. These shifts are largely due to the exchange of food particles and their movement with regard to the surrounding media.

Using various physical and chemical methods such as high pressure, radiation, sterilisation, or active agents, food stabilisation and preservation can be achieved. However, packaging is a prime necessity for the processing and preservation of the freshness of food commodities. In order to minimise mass transfer between food goods and the storage environment, the efficiency of synthetic packaging materials can be judged by their effectiveness. Resin, cellulosic and plastic films are some of the synthetic films that make use of composite or multilayer film packaging (in this case, the edible layer is the layer in direct contact with the food product) that greatly reduces the selective transfer of gas and solvent. However, plastic films are not uniformly suitable. A mixture of synthetic and edible packaging has been suggested to improve the safety of food. As natural and biodegradable substances from agriculture subsist, edible packaging does not do any damage to the ecosystem.

It is possible to describe edible films as a thin layer of material that can be eaten along with food. It provides oxygen and moisture barriers, thus extending the shelf life of food. The edible layer may be a full layer that covers the food, or it can be a continuous layer between the components of the food (1996-Guilbert). In recent years, edible films and coatings have gained more attention as they have advantages over synthetic films, and the very main thing is that they can be eaten along with the food product. In cases where the film cannot be consumed, its disposal is also healthy, environmentally friendly and does not affect the environment.

Compared to synthetic films, the biodegradable and renewable natural agricultural resources from which the edible films are made will easily degrade. The properties of edible films also act as antimicrobial and antioxidant agents. Edible film processing and disposal do little or less damage to the environment, but typically have low mechanical and barrier properties. (In 1986, Kester and Fennema).

In order to acquire technical knowledge for the creation of edible films, methods to improve their properties for food applications, much further study and analysis is still needed (1993 by Danhowe & Fennema).

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3. HISTORY OF EDIBLE COATINGS

The trend and use of edible films in food commodities might sound recent, but many years ago, their use began to cover food commodities. Since the 12th and 13th centuries, China has been practising the use of wax to slow the process of dehydration in citrus fruits.

The application of meat coatings has also been practised since the sixteenth century, when films were used to prevent meat from shrinking. The fat was used to coat or cover the pieces of meat. Other techniques, such as coating with gelatin film, also came into use for meat preservation later in the last century. Yuba, an edible film obtained from boiled soy milk skin, has historically been used in Asia for the preservation of some food resources since the fifteenth century.

Nuts, almonds, and hazelnuts were coated with sucrose in the nineteenth century to keep them from becoming rancid during storage. In water, waxes, emulsions and oil are often used as spreads for fruits that enhance their appearance (shininess), colour, ripening phase, water loss retards. Many edible polysaccharide coatings such as pectin, carrageenan, alginate, cellulose ethers and starch derivatives have been used to improve the consistency of stored meat.

4. EDIBLE PACKAGING: PREREQUISITES

THIS CHART ENLISTS SOME OF THE PREREQUISITES OF AN EDIBLE PACKAGING.

5. EDIBLE FILMS AND COATINGS: CLASSIFICATION

a. Polysaccharide

In polysaccharide-based edible films, cellulose chitin and chitosan, starch derivatives, seaweed extracts and exudate gums are used. Polysaccharides have low water vapour and gas barrier properties due to their hydrophilic character. Polysaccharide-based films, however will delay the loss of moisture from food products at a good pace. (Kester and Fennema ;1986).

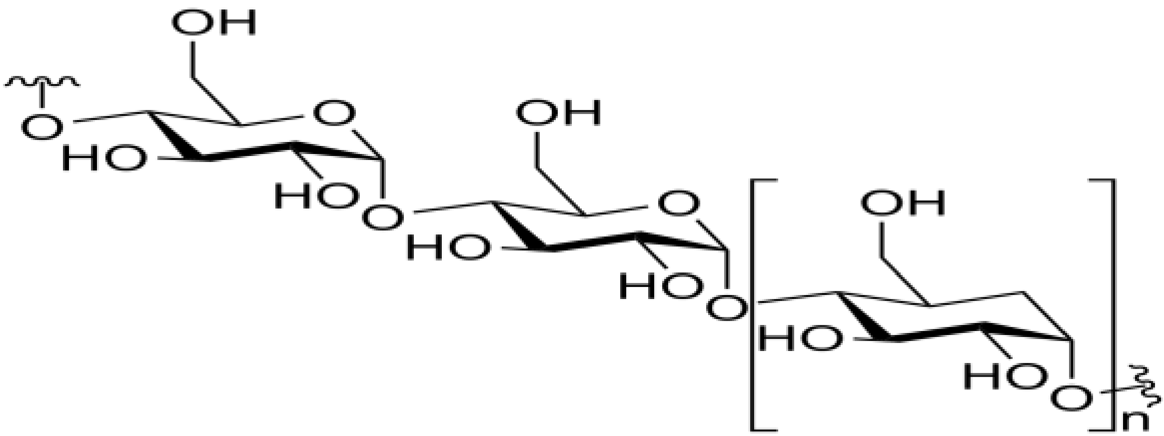

Figure A. Structure of Polysaccharide

b. Cellulose & derivatives

Cellulose consists of units of D-glucose, which are connected together by glycosidic binding of β 1-4. The natural state of cellulose consists of, alternatively, the hydroxyl methyl groups of anhydroglucose residues located below and above the polymer backbone plane, providing a strong packaging and highly crystalline structure for the polymer chain.

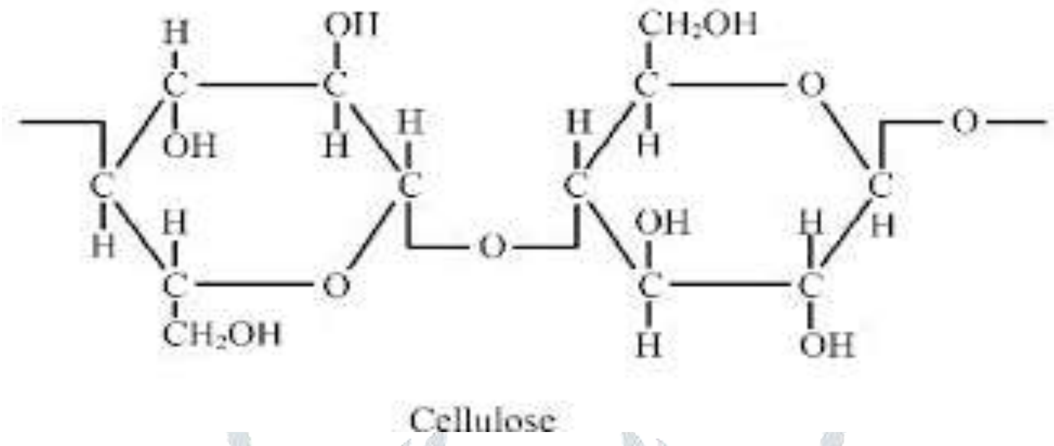

Figure B. structure of Cellulose

Via treatment with alkali, followed by reaction with chloroacetic acid, methyl chloride, propylene oxide yielding carboxy methyl cellulose (CMC), methyl cellulose (MC), hydroxypropyl cellulose (HPMC), the water solubility of cellulose can be increased. MC, HPMC, HPC & CMC films have good film forming characteristics, they also have no odours or taste, and are clear with good strength (Krochta and Mulder Johnson ,1997). MC (Kester and Fennema, 1986) are the most resistant films to water. The use of MC & HPMC is carried out to slow the absorption of oil in deep frying food items (Kester & Fennema, 1986). (1997, Balasubramanium et al). MC can also be used in bakery products as a hurdle to lipid migration (Nelson & Fennema, 1991). Several more composite films consisting of MC or HP MC have been investigated. Such films have water vapour permeability comparable to polythene of low density (LDPE).

c. Chitosan and Chitin

Chitin is after cellulose) the second most abundant biopolymer found in nature. It is present in the walls of fungal cells, crustacean exoskeletons and some other biological material as well (And rady and X4,1997). Chitin is composed of poly [β-(1-4)-2-acetamide-D-glucose] and is structurally similar to cellulose, except that the secondary hydroxyl group is substituted by an acetamide group on the second C atom of the hexose repeat unit.

In the presence of alkali, chitosan can be extracted from chitin via the deacetylation process. Chitosan consists of (β-(1-4)-2 acetamide-D- units of glucose. In co-existence with their cationicity and their formation properties, chitosan has antimicrobial properties (Muzzarelli, 1996).

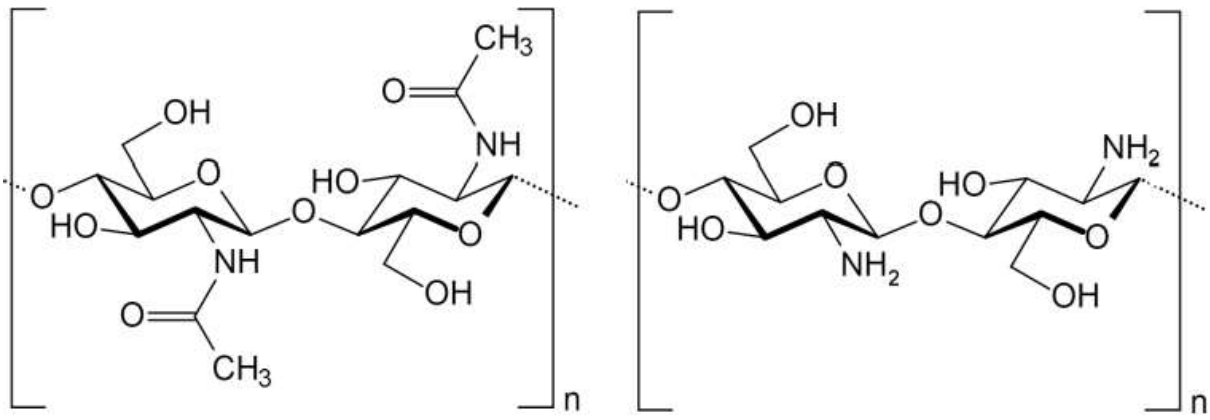

Figure C. Structure of Chitin and Chitosan

Using chitosan, semi-permeable coatings can be created. These coatings delay the ripening process and decrease the rate of fruit and vegetable perspiration. Chitosan-based films are a rugged, transparent, versatile, good barrier to oxygen (Sandford, 1989; Kalplan et al 1993). Chitosan-based films demonstrate stability in mechanical and barrier properties and even in storage, according to (Buttler et al, 1996). Strawberries, Cucumbers, Bellpepers, are some of the fruits and vegetables used as antimicrobial coatings for the chitosan film (Ghaouth et al, 1991a, 1991b) and as a gas barrier for Apples, Pears, Peaches & Plums (Elson and Hayes 1985; Davies et al, 1989).

d. Starch

Starch is a polymeric carbohydrate made up of glucose anhydrous units. Starch consists of a linear glucose chain known as amylose and a ramified glucose chain known as amylopectin (Rodriguez et al, 2006). Starch is also used by the food industry to produce films, since starch has low cost and good mechanical properties (Xu et al., 2005).

Corn starch contains around 25% amylose and 75% amylopectin and is considered good for film forming.

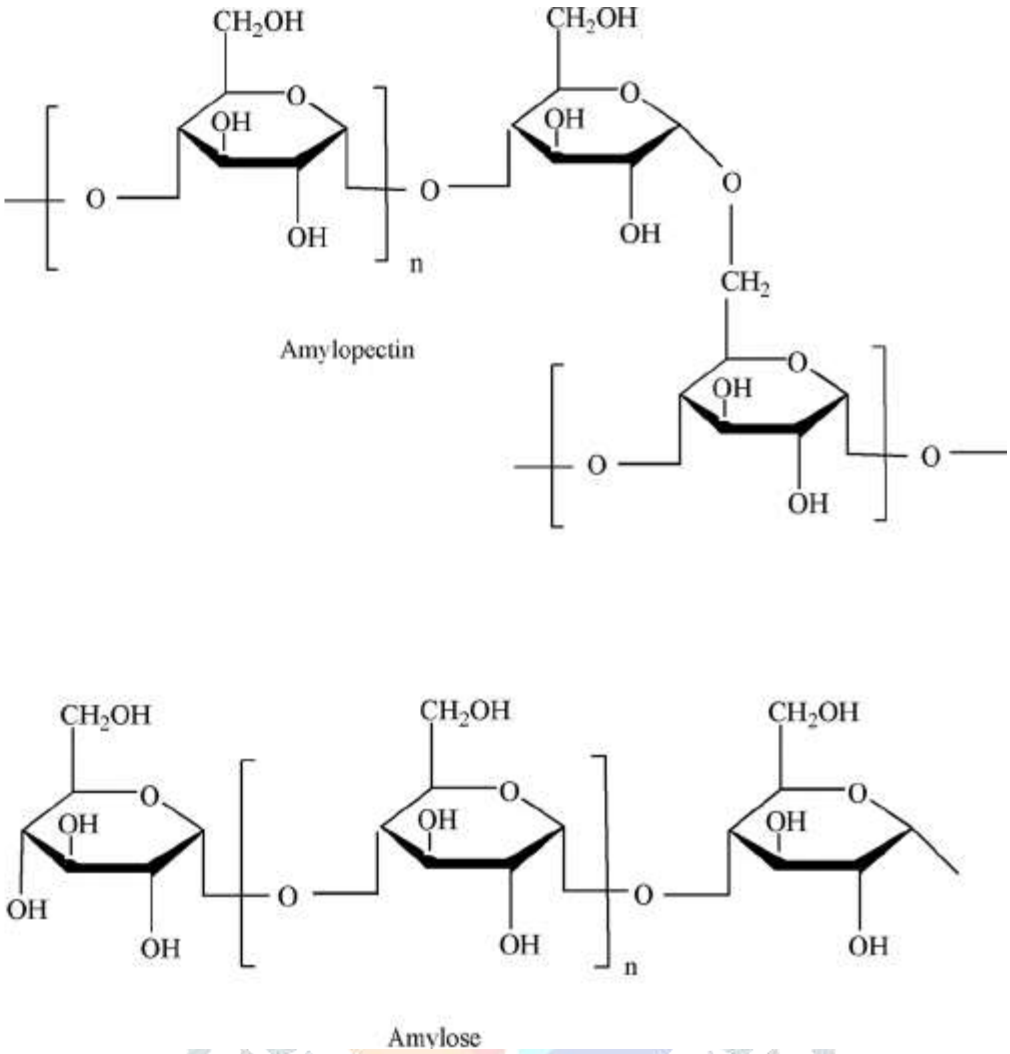

Figure D. structure of starch (Amylopectin & Amylose)

e. Lipid films

Acetylated monoglycerides, natural wax & surfactants are the basis for lipid compounds which can be used as a protective coating. The most realistic and efficient lipid material is beeswax paraffin wax. Blocking the transport of moisture is the primary function of lipid coating. The lipid membranes must be further assisted with the aid of the polymer structure matrix in order to offer mechanical strength.

f. Waxes and Paraffin

Paraffin wax is derived from crude petroleum distillate fractions. In general, the use of paraffin wax on raw fruits, vegetables and cheese is permitted. Carnuba wax is an exudation of the leaves of the palm tree. (*Cerifera Copoernica*). The development of honeybees consists of beeswax. Candelilla is sourced from a plant called candelilla. The mineral oil contains liquid paraffin & naptheric hydrocarbons (Hernandez, 1994). Waxes (skin of fresh foods) when applied to surfaces give the surface a shine and often serve as a barrier to moisture and gas. Application of thin layers of waxes is considered edible, but they must be removed before consumption of food (certain cheese) when applied as thick layers.

Figure E. waxes and paraffin

g. Shellac resins

Lacifer lacca, an insect that secretes shellac resins, consists of a mixture of aliphatic alicyclic polymers of hydroxyl acid. Shellac is not authorised by GRAS, but in food coatings it is used as a direct food additive. It is commonly used in the pharmaceutical industry, and it is considered to have very few applications in the food industry (Hernandez, 1994). In citrus & other fruit films, extensive use of resin & its derivatives is found (Hagenmaier and Baker,1993).

Figure F. Shellac resins

h. Protein films

Fibrous & globular are the two types in the native state in which protein normally occurs. The principal structural material of animal tissue is fibrous protein (Scope,1994). Through hydrogen bonding, fibrous associate each other in parallel fashion, while the globular protein exhibits complex spherical structure, kept together by a mixture of hydrogen, ionic, hydrophobic, and covalent bonds. (Range,1994).

Figure G. protein film

The location of amino acids in the protein polymer chain and the number of components of amino acids influences the physical and chemical properties of proteins. Many proteins have been researched and used as edible films, including gelatin, casein, whey proteins, corn zein, soy protein, wheat gluten, peanut protein, mung bean protein (Gennadois et al., 1993; Bourtoon, 2008).

i. Gelatin films

Gelatin production can be achieved by regulated hydrolysis of the insoluble fibrous protein, collagen. As the main constituent of skin, bones and connective tissue, collagen is extensively present in nature. Gelatin consists of high amounts of glycine, proline, and hydroxyproline amino acids. Food components in the low moisture or oil process can be encapsulated using gelatin to provide a buffer against light and oxygen (Gennadios et al, 1994). In order to reduce oxygen, moisture and oil transport, gelatin coatings have also been used on meats (Gennadios et al, 1994).

Figure H. Gelatin film

j. Corn zein films

The crucial protein present in maize is Zein. It dissolves 70-80% ethanol due to zein's prolamin protein nature (Dickey and parris 2001,2002; handry;1997). The presence of zein is hydrophobic. Zein has a high non-polar amino acid content, so it is naturally hydrophobic (Shukla and Cheryan, 2001). Zein has the potential to produce excellent foaming properties for film. During the formation of zein films, hydrogen, hydrophobic and minimal disulfide bonds are formed between zein chains (Guilbert, 1986). By drying the ag, edible films can be obtained. (Gennadios and Weller, 1990) ethanol solution of zein. Those movies are delicate, hence req. Inc. the flexibility to incorporate plasticizers (Park, 1991). Zein films have a strong barrier to moisture as compared to other edible films (Guilbers,1986).

Figure I. Wheat zein film

k. Wheat gluten films

The protein present in wheat flour, which consists of a combination of polypeptide molecules, is wheat gluten. Because of its cohesiveness and elasticity, film forming characteristics can be found in wheat gluten. Gliadin and glutenin produce wheat gluten. Gliadin is soluble and glutenin is not soluble in 70% ethanol (Gennadios and Weller, 1990). By drying the aqua solution of ethanol containing gluten, edible films can be obtained (Gennadios and Weller, 1990).

Figure J. Wheat gluten film

In addition to hydrogen, hydrophobic bonds are critical in the formation of wheat gluten film structure, the breakdown of native disulfide bonds during heating and the formation of new disulfide bonds during film drying (Gennadios and Weller, 1990). When gluten films are applied to glycerin (plasticizer), it increases the stability of the film (Gennadios et al. 1994), but the addition of sorbitol decreases the barrier properties of film power, elasticity & water vapour (Gontard et al. 1992).

The films created by spray drying were stronger than the films prepared using flash drying, according to research conducted by Herald et al. (1995).

l. Soy protein films

The protein content of soyabean (38-44 percent) is much higher than that of the protein present in cereal grains (8-15 percent) but is soluble in dilute neutral salt solutions. The protein content of soyabean is insoluble in water. Production of edible films based on soy protein can be achieved in two ways: the formation of surface film on heated soy milk or the formation of film from soy protein isolate (SPI) solutions. (1992 by Gennadios and Weller). By grinding them along with water, soymilk can be obtained and followed by 2separation of milk from soyabeans.

Figure K. Granules of soya protein

6. EDIBLE FILMS: APPLICATIONS

The selection of the type of edible film to be used can be made solely on the basis of the food product characteristics which are needed to be covered. For various forms of food items such as fruits, vegetables, meat & poultry, grains, candies, fresh and refined foods, many different types of edible film materials such as proteins, lipids, carbohydrates, and their mixtures have been used.

a. Fruits, nuts, grains & vegetables

The main reasons that account for the spoilage of fruits and vegetables are respiration, transpiration during maturation & storage, or microbial growth, particularly moulds & rots (Baldwin and Baker et al., 1994). For fruit coatings such as apple, strawberry, orange, peach, mango, date, guava, lychee, coconut banana, melon, celery, sweet corn, eggplant, radish, cabbage, tomato, cucumber, carrot, root crop, pumpkin, asparagus, pepper, and so on, waxes such as (Paraffin, Carnauba, Mineral Oils, Candellila, Beeswax, Polyethylene, Shellac) are widely used (Baldwin et al., 1994). Whether used alone or mixed with lipids, waxes and oils act as a good barrier to water. Anaerobic conditions are induced by a thick layer of the same, however. (by Lindstrom et al. in 1992). Films such as corn zein, when applied to tomatoes, contributed to delayed changes in colour, weight, firmness. (Park and Weller et al. in 1993; Park Chinnan et al. in 1994). Edible films can be integrated with anti-microbial agents in order to minimise the spoilage of the product on which this film is meant to be used.

Chitosan-based films are found to have selective moisture and gas barrier properties when applied to fruits such as strawberries and raspberries, thus allowing good breathing and less loss of water through transpiration (Ghaout and Arul et al., 1991).

To shield them from oil migration, coatings derived from methyl pectin or cellulose have been used on nuts, almonds, hazelnuts and peanuts.

According to Mazza and Qi (1991), non-enzymatic browning in potatoes can be prevented by coating based on starch, gums and gelatin. In order to preserve plenty of fruit (apricots, oranges, guavas, bananas, mangoes, pineapples), air drying or osmotic dehydration is used.

b. Confectioneries

In order to minimise moisture & oil migration, edible films based on cellulose and its derivatives are well known (Nelson and Fennema et al., 1991). Films and coatings of methyl cellulose show very low lipid permeability, which can also minimise fat migration.

When used as a film-forming solution, a mixture of zein-ethanol gives a better effect than standard confectionery glaze (Gennadios and Weller., 1990).

The normal conventional sugar coatings can be substituted by sorbitol-based hard coatings on chewable dragees, according to Dyhr and Sorensen (1991). As a moisture impermeable barrier (Torres et al.,1990), the use of bilayer methylcellulose and palmitic acid coatings in Sundae ice cream cones was evaluated as a result of the cone maintaining its crispness for more than 3 months. Extensive applications of edible films are now being made for food items, but the availability of data in science and patent literature is less significant.

c. Meat, poultry and seafood

To improve the stability of meat during storage and commercialization, the use of edible films is very common.

This approach reduces the growth of microbes when covering the lamb carcass using gelled calcium chloride, but the meat is not protected from water loss (Lazarus and West et al., 1976). The coating of salmon with a mixture of whey proteins and acetylated monoglycerides secured it against lipid oxidation and water loss, according to Suchell and Krochta (Stuchell and Krotcha.,1994). The improvement in texture and juices was recorded when the coating of beef sheaks, pork chops & skinned chicken drumsticks was achieved using a combination of alginates & starch (Allen and Nelson et al., 1963). Coating with collagen, caseins and cellulose derivatives such as methylcellulose, carboxy methylcellulose, hydroxypropyl methylcellulose is an efficient way to increase better adhesion and decrease oil absorption during frying of meat & fish. (Feeney and Hararalampu ret al.,1992; Polanski., 1993).

Soluble cellulose derivatives can be used to minimise water loss when cooking meat water.

The mixture of hydrocolloids (gums, alginates, cellulose derivatives, etc and acids (acetic or lactic acid) can be used to suppress the growth of microorganisms such as Listeria monocytogenes.

Preservation techniques such as drying or smoking are also being replaced by edible collagenic or cellulosic films. Edible films provide greater storage control.

7. FINAL REMARKS

The idea of edible films and coatings offers exciting ways to create new packaging materials and to enhance the consistency and protection of food during processing and storage. This is because edible films and coatings have a variety of properties, so they can be used where it is not practical to apply plastic. Intelligent packaging that has both active and selective characteristics is edible packaging. The natural polymers obtained from agricultural processing are edible films or coatings, which are therefore healthy for the environment. Three types may be used to describe the components used in the creation of edible films: hydrocolloids, lipids, and composites. Edible films are 10-15 folds greater than polyethylene or polypropylene films, but they are used in very few food products with added value. There is still a need for a lot of study on the methods of film production and the enhancement of their properties. That being so, both plastic and edible films continue to thrive as the food packaging of tomorrow.

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