

## **PROTEIN-BASED EDIBLE FILMS A REVIEW:**

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### **ABSTRACT**

The edible or bio-degradable films are materials which compose of suitable means to increase the storage time of food and improve their condition externally conductive to environmental contamination.

The protein, lipid and polysaccharide are materials can form the edible film. Were proteins based edible films are considered mainly appropriate in food coating. Collagen, gelatin films, corn zein, wheat gluten, soy protein, casein and mung bean protein are the most types films used in coating food. The protein edible films have remarkable gas block features equalled to films made from polysaccharides and lipids. These films have mechanical properties which make it best than polysaccharide and fat based film Although the water vapor permeability is low and the tensile strength is less than the polymers used in the packaging, many modifications have been used to improve the functional properties of the film via physical, chemical and enzymatic methods and bonding with hydrophobic materials and some polymers

## INTRODUCTION

An imperative role of edible films has been recorded in food industry programs to serve humankind significantly. The edible films and coatings have been used in food preservation for periods. For a long time, edible film and coating were used in food protection worldwide. The development in the food industry since more than hundred years wax was used in the coating of food to improve the storage time. The essential goal was to prevent the loss of humidity, to keep the feature and texture while the period of storage. Nowadays, waxes materials are yet used to store vegetables, fruits, and meats for elongated storage time and to long shipping time. However, now there are extra elements prepared for the coating of edible film. These substitute origins, along with enhanced treatment techniques, have increased of using the simple moisture barriers and coating of the edible films.<sup>(23)</sup> Currently, there are more than 12 kinds of commercially used edible films and coatings with sub-brands used for preserving food materials. The edible films are categorized into three groups taking into consideration, the nature of their components: hydrocolloids (containing proteins, polysaccharides or alginates), lipids (constituted by fatty acids, acylglycerols or waxes) and composites (made by combining substances from the two groups)<sup>(9)</sup>. Numerous papers have been published and reviewing the features of edible films and coatings made from bio-polymers like soy protein, wheat gluten, cellulose, starch, and casein<sup>(17),(28),(18),(48)</sup>. Although several bio-polymers have been considered as edible film and coating. This article highlights on proteins as an edible film. The edible film is a thin continuous sheet formed from a biopolymer matrix which is cohesive enough and has the physical integrity to stand alone. The thickness of edible films is typically 2-10 mils (0.050-0.250) mm. The edible films of biopolymers are to control the mass transfer of multiple compounds including aroma,

gas, oil and water that vapour into or out of food, as well as conserving food quality). Edible films must have some features such as mighty and soft to withstand forces adept during processing and handling <sup>(27)</sup>. The edible coating can improve the presence of the goods by combining gloss or colour and making it more attractive to users. The edible film is the form adopted to investigate mechanical, block and surface characteristics, while the coating is considered as one kind of utilisation film. Both edible films and coatings can be used as a transformer of incorporating natural or chemical antimicrobial agents, antioxidants, enzymes or functional ingredients such as probiotics, minerals and vitamins <sup>(43)</sup>.

The aim of the review was to highlight the importance of the use of plant and animal proteins in the production of edible films to reduce the environmental risks resulting from the use of plastic packaging.

### **Protein-based films and coatings**

Protein is an imperative organic polymer in the production of films and edible coatings, along with their profusion and their sustainable kind. The numbers and types of amino acids have differed in protein materials. There is a renovated awareness in edible membranes composed of natural sustainable polymers such as proteins. These films are utilised to decrease wetness damage, oxygen and permeability, decrease lipid movement, improve mechanical features, as well as increase the qualities of food and have degradability compatible with conservational conditions <sup>(7)</sup>. Protein is also characterized by its ability to carry anti-microorganisms, flavours and colours <sup>(23)</sup>.

Protein membranes are preferred in mechanical features in comparison to membranes formed from polysaccharide and lipids. Since the proteins have a unique composition which provides a number of useful features. Therefore, these films can procedure links between several sites. The high voltage to procedure multiple cross-linkages,

<sup>(45)</sup>. Animal (milk and whey proteins) and plant (such as soy and zein proteins) protein films exhibit well oxygen barrier, carbon dioxide barrier and mechanical properties than polysaccharide films. However, similar to polysaccharide films, due to their hydrophilic nature, generally protein films grip poor water vapour barrier property <sup>(4)(5)</sup>. Other Studies have been shown that the concentration, structure, shape, and size of plasticizers all these features are affecting the properties of protein films: insoluble proteins, like wheat gluten and corn zein, create insoluble coatings, while soluble proteins give coatings of unreliable solubility, depending on the type of the protein, the states of the coating process. Most of the protein in soybeans is insoluble in water but soluble in dilute neutral salt solutions, therefore, soy protein is not considered as a hydrocolloid.

From different sources such as derivatives of polysaccharides, lipids compounds, vegetable or animal proteins source, and complexes involving a combination of the preceding ingredients can produce edible films and coatings <sup>(42)</sup>. The investigate that done about the protein from different diversity to produce a variety of edible films and coating materials from different sources which played an important role in food coating whey proteins (WPC and WPI) <sup>(47,1,12)</sup>.

### **Total milk proteins**

The components of milk proteins or TMP can produce edible films and coating. A lot of studies have been done to evaluate the composition and protein structure effects on barrier properties of edible films. The interactions in edible films depend on nature and type of the conditions of the surrounding of the protein. the edible films, proteins of milk and coatings act as a protecting layer on foods or among food ingredients. Adequate mechanical energy is required to save the integrity of covering

throughout delivery. Furthermore, the fundamental determinant for the approval of edible films or coating is their clear demand. Moreover, pure milk proteins films are suitable blocks to gas transmissions since their combined intermolecular junctions (40), (44).

Preparing films of whey protein concentrate and casein through moulding by softening with glycerol and sorbitol individually. The kind of plasticizer, biopolymers and its concentration effected upon the features of the edible films. By developing the concentration of plasticizer, the thickness of the edible films, water vapour permeability (WVP). while the tensile strength and adaptable modulus were reduced. Casein films which used in food packaging grip low O<sub>2</sub> permeability and sufficient force, however, it has less elasticity and it has further sensitive to humidity. The casein based film can be utilised in a different type of marketing purposes by changing the film depend on the surroundings. Pectin could be supplemented to the formulations of casein films designed for packaging of food aims (6),(39).

Whey proteins obtain great O<sub>2</sub>, odour and oil block film at minimum-to-moderate moisture. In addition, the mechanical features of whey protein film are sufficient to implement strength while utilised as a coating in food goods, films insulating layers of various food or film made into bags for food components. Irradiation and heating are one of many methods can be used to produce whey protein. Films of whey protein is a medium permeability of water vapour because it is a hydrophilic protein while it is a select barrier to O<sub>2</sub> as it reduces oxidation in food and decreases enzymatic attenuation reactions (32). With less permeability to wetness and water vapour along with an acceptable barrier to smell. Whey proteins can make water-soluble films. In addition, films formed without plastic are hard and can be separated. To increase the flexibility of the membrane plasticizer is added (37).

### **Gelatin films**

Among hydrocolloids, material gelatin is remarkable in creating a thermo-changeable material with a melting point near to 27°C. Which consider is most important in edible and medicinal purposes industry. Essentially, gelatin can be achieved by keeping hydrolysis from the unsolvable proteins, collagens, that is commonly formed in normal as the main component of bones, skin and connective tissue. From fresh series amino acids, gelatin can be made. The characteristics of gelatins are included hydroxyproline, proline and high amount of the amino acids glycine. The aqueous solutions of gelatin are in the sole state and physical formation, where gel is interchangeable on freezing. Through gelation, the chain goes through a transition process to order system disorder and have a tendency to obtain the collagen. Through gelation, the chain goes through a transition process to arranging system disorder the collagen triple-helix structure <sup>(46)</sup>. The functional characteristics of tuna had been studied by<sup>(26)</sup> and he found the gelatin obtained from tuna fish was yellowish and opacity membranes with a tensile strength 48.57 and MPa elongation of 15.2% and water vapour permeability of 110 g.mm/m<sup>2</sup>.h.KPa while the permeability of gases is 5.3 cm<sup>3</sup> / m<sup>2</sup>. Day, as estimated thermal properties were the degree of glass transition 56.30 m<sup>0</sup> and thermal stability 260 m<sup>0</sup>. Nonetheless, films extracted from gelatin, such as greatest protein film, haven't a perfect water vapour limit, that restricts its utilization as edible films and bio-material.

### **Wheat gluten films**

Gluten that produces from wheat flour consider water-insoluble protein that contained a blend of poly-peptide molecules, and deemed to be universal protein. The elasticity and cohesiveness of the glutes give probity to the dough of wheat and promotes film composition. Wheat gluten is formed of pair major collections of

water-insoluble proteins: gluteins containing high molecular weight proteins and gliadins, consisting of low molecular weight proteins. The increasing of a plasticizer such as glycerol in gluten film is required to increase the elasticity of wheat gluten film. Despite, developing film elasticity by improving plasticizer content might decrease the strength, flexibility and water vapour boundary features of the formed film. Moreover, the film's appearance and mechanical properties will be affected by the purity of wheat gluten; increase the purity of gluten results in clearer films and stronger. Films of gluten which extracted from wheat are powerful with O<sub>2</sub> barriers, however poor for H<sub>2</sub>O vapour barriers. wheat gluten films are poor resistance to water vapour due to the considerable quantity of hydrophilic plasticizer combined to provide sufficient film flexibility and the protein hydrophilic nature. Using heat curing or cross-linking agent such as glutaraldehyde can be improved the qualities of wheat gluten films.

### **Soy protein films**

proteins of soybean have 200 to 600 kDa molecular weights. Globulins are forming ninety percent of soy proteins. Moreover, about 31-37% of extractable soy protein has the ability to form polymerization. 7S and 11S are the most fractions that can be extracted from soy protein<sup>(9)</sup>. The chains in soy protein content together polar and non polar sides. There is great intra- and inter-molecular interactions, such as dipole-dipole, hydrogen bonding, charge-charge, and hydrophobic interactions. The segment rotation and molecular movement restricted by polarity and strong charge of the two side chains of soy proteins, which enhance the properties of the films in coating foods <sup>(49)</sup>.

### **Corn-zein Coatings**

Zein is a natural corn protein produced from corn gluten meal and is insoluble in water, but soluble in aqueous alcohol, glycol esters and glycols <sup>(11)</sup>. It has good film-forming, binding and adhesive properties. Corn-zein coating is a good barrier to oxygen. It prevents the change of the colour, loss of hardness and weight, and increases shelf life of tomatoes. Moreover, Its considered water vapour permeability, nevertheless, there were about 800 times greater than a typical shrink-wrapping film <sup>(34)</sup>, indicated that corn- zein film delayed colour changes, reduced weight loss, inhibited ethanol production, paused ripening, and reduced stiffness damage of tomatoes. the thickness of the coating affects the degree of colour change. increased levels of oxygen and carbon dioxide led to Increased thickness level of coting <sup>(41)</sup>.

### **2- Edible protein films modified by enzymes.**

To increase the functionality of protein film changing the polymer via the cross-link of the polymer chains is the alternative method that can be used. <sup>(35)</sup> suggested that the functional properties of cytosine membranes can be improved by adding whey proteins and by the presence of Transglutaminase TG enzyme because the whey protein is the donor of the acyl donor and the accept acyl acceptor. The enzyme causes the formation of internal covalent bonds between lysine and glutamine in the different sites of whey proteins. The bonds can reduce the movement of the molecular chain in the polymer matrix and thus increase the tensile strength and reduce the expansion with a low concentration of protein. <sup>(10)</sup> added a TG enzyme with an efficiency of 5.8 units / ml for the 5% whey protein with 2.5% cytosine and obtained low-transparent and transparent membranes in a wide range of pH with good biodegradability as well as increased mechanical resistance, increase tensile strength, increase flexibility, improve oxygen sequestration capacity and reduce

water vapor permeability. <sup>(2)</sup> used Transglutaminase enzyme in whey protein film; the values of water vapour permeability was decreased with enzyme concentration 0-0.3%; tensile strength was decreased; elongation percentage elevated and solubility increased for protein concentrations 4, 6, 8 and 10%. Microscopic examination of enzyme treated membrane showed that smooth with homogenous structure with fewer pits and pores while thermal degradation occurred at 286.72 °C.

### **3-Modification of edible protein films by irradiation High-energy:**

One of the most common technologies used to modify the polymers is irradiation. <sup>(38)</sup> Improving the useful features of protein films or ionizing radiation have been tried, the effects of Gamma-irradiation on proteins through making conformational changes, oxidation of amino acids, and the rupture of covalent bonds and formation of protein free radicals Gamma irradiation affects the proteins by causing molecular conformational changes, oxidizing amino acids, cutting covalent bonds, forming free radicals, and free ions that lead to bonding. bonding, chain separation, and some volatile components, causing a foul smell of irradiated membranes in case of increased dose <sup>(8)(3)</sup>. Wittaya <sup>(33)</sup> Reported that the chemical stability and water vapour permeability was improved by using gamma irradiation. In addition, the results presented that water vapour permeability was reduced by using gamma irradiation. In order to induce the modifications on the protein structure, gamma irradiation application was used and indicate the more compact structure and improve block properties. Consequently, better barrier properties, proportional to the irradiation doses. Future investigations will be cured out to expand the effectiveness of gamma irradiated coating on fruits storage stage. 35.0 kGy dosage was selected as the best to achieve this study. However, the dose of 45.0 kGy reached more

modifications on the film structure but produced un preferable flavour, led to difficulties to be used on food application <sup>(24)</sup>. <sup>(38)</sup> measured the thermogravimetric analysis TGA of 20%, 10% PVA polyvinyl alcohol and 20% 10% ka gamma irradiation with a dose of 0 - 50 kgy and found an increase in the thermal stability of radiation-treated membranes relative to non-membranes. The treatment also increased thermal stability with increased irradiation dose due to irradiation and PVA as well as increased membrane tension strength and elongation ratio with increased radiation doses and increased PVA ratio.

Protein-based films are edible and biodegradable as well to the possibility of eating with the product envelope and its important contribution In reducing environmental pollution, with many other advantages to obstruct the transmission or migration of moisture, gases and compounds flavor of volatile food of old-age reservoir, failure to protect against mechanical damage Reducing the fragmentation and breakage and improving the mechanical circulation characteristics of food

### **الاغشية البروتينية القابلة للكل**

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### **الخلاصة**

تعد الاغشية الصالحة للأكل او القابلة للتحلل وسائل مناسبة لزيادة فترة خزن المواد الغذائية وتحسين نوعيتها دون الاسهام في التلوث البيئي ،ويمكن تحضير الاغشية القابلة للأكل من البروتينات والدهون والسكريات المتعددة وتعد الاغشية البروتينية اكثرها اهمية. بروتينات الكولاجين ،الجيلاتين ،بروتينات الذرة (الزينة) ،كلوتين الحنطة ، بروتينات فول الصويا ،الكازين ،بروتينات البقوليات هي البروتينات الشائعة في انتاج الاغشية البروتينية القابلة للأكل ولها القدرة

على احتجاز الغازات كما هو الحال في الاغشية المصنعة من السكريات المتعددة وتمتلك الخصائص الميكانيكية للأفلام المصنعة على البروتين على خواص أكثر من تلك المصنعة من السكريات المتعددة والأغشية المصنعة من الدهون وذلك لاحتواء البروتين (على أساس ٢٠ مونومرات مختلفة) والتي تمتلك مجموعة كبيرة من الخصائص الوظيفية ، وبالرغم من قلة نفاذية بخار الماء وانخفاض قوة الشد مقارنة بالبوليمرات المستعملة في التغليف لذا استخدمت العديد من التحويرات لتحسين الخواص الوظيفية للغشاء عن طريق الطرق الفيزيائية و الكيميائية والانزيمية والربط مع المواد الغير محبة للماء وبعض البوليمرات

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