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# Edible films in seafood

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## Abstract

Fish and seafood products are highly perishable in nature they lossess  their freshness shortly after death which occurred through several biochemical reactions such as such as changes in the quality of fish protein ,lipids level and development of biogenic amines, hypoxanthine and microbial spoilage. The changes in fish and seafood muscles lead to decay in the quality (e.g in sensory quality and nutritional content of nutritional value of fish. Seafood and fish quality maintainance is crucial to hinder the loss of this nutritionally quality of fish. Therefore, seafood and fish-processing industry are currently in search of alternative techniques of preservation that can prolong the shelf-life of fresh fish. Various preservation techniques have been developed in order to prevent spoilage in food and to maintain quality and extend shelf life. Edible film and coating are famous in the food industry, because they are economically low, abundantly available. Coating and film are produced from several carborhydrate and protein origin and these coating and film are safely applied for enhancement of seafood quality and to prolong their shelflife. Edible film and coating have several advantages because they function in so many ways as following: they are safe to be consumed and biodegradable; are additives to  the nutritional value of seafood products; enhancement of organoleptic characteristics of food, like appearance, smell, and flavor; lower packaging volume, weight and waste; contain antimicrobial agents and antioxidants; prolong shelf-life and quality enhancement of non-packaged items; guide over inter-component movement of moisture, gases, lipids, and solutes. Food additives have been integrated successfully into edible film and coating, these additives have anti-browning agents, antimicrobials, flavors, colorants, and several functional substances. Techniques of application include Immersion, spraying and dripping. This article reviews the types of edible film, their importance and application techniques and their effects on the different materials in seafood.

**Key words:** Edible films, Seafood quality, Seafood shelf-life

## Review article

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## INTRODUCTION

Fisheries and aquaculture are great source of economic and social benefits (Watterson et., 2008).Biochemical Composition of fish consists Moisture contents 65-80%, Protein 15-20%, Fat 5-20%, Ash 0.5-2% (Sauvant, 2004). It also contains antioxidants such as proteins, vitamins, carotenoids and tocopherols, Fish is very rich in nutrients and its of great benefit to humans health. Its so rich in long-chain omega-3 polyunsaturated fatty acids (PUFA) which are required for growth and development. Among these long-chain fatty acids, especially eicosapentaenoic (EPA, C20: 5n-3) and docosahexaenoic acid (DHA, C22: 6n-3) are widely used in human health, such as reducing the risk of cardiovascular diseases and some types of cancer, contributing to nervous system functions and body development, this function has been accepted as responsible for the beneficial effect (Shahidi, 2015). The rapid increase in the world population, the tendency to raise people's living standards and the rapid growth of food, increased the demand for ready-made foodstuffs and as a result, the production of foodstuffs became an industry branch. Thus, the number of food additives and preservation methods used in the production and production of processed foods is increased rapidly (Gennadios, 1997). However, losses of seafood and cultured fish occured due to post-harvest handling, processing and storage methods (Gustavsson et al., 2015). Post-harvest losses could be in various forms such as nutritional losses, spoilage of seafood products due to poor processing, economical and physical losses (Hall, 2011).In the world, fish losses that occurred through spoilage is around 10%(10 to 12million tons per year) recorded for both aquaculture and seafoods (Socaciu, et al., 2018). Fish is highly perishable in nature compare to poultry and meats, its losses the fresness shortly after death which occurred through severals biochemical reactions such as such as changes in the quality of fish protein,lipids level and development of biogenic amines, hypoxanthine and microbial spoilage (Matak et al., 2015). The changes in fish and seafoods muscles leads to decay in the quality (e.g in sensory quality and nutritional content of nutritional value of fish. Seafood and fish quality maintainance is crucial to hinder the loss of this nutritionally quality of fish (Mohan et al., 2012).Therefore, seafood and fish-process industry are currently in search of alternative techniques of preservation that will prolong the shelf-life of fresh fish (Ashie et al., 1996). Various preservation techniques have been developed in order to prevent spoilage in food and to maintain quality and extend shelf life. Recently, edible and recycled films and coatings prepared with proteins, polysaccharides and lipids have become increasingly important in food storage. Edible films and coatings is a thin – layer food that is formed from natural food material to preserve foods and extend their shelf life (Dursun & Erkan 2009). Edible films gives physical protection (Min et al., 2005) to preserve food products from mechanical deterioration, physical, chemical and microbiological spoilage. These products can be consumed, biocompatible, nontoxic, and function as a barrier and a carrier of food additives e.g (antioxidants and antimicrobials).

Types of Edible film and coating

Edible films and coatings are the thin layer of food that is formed on the surface of foods and can be consumed with food and obtained from natural sources. They extend the shelf life of foods, improve their organoleptic properties, nutritional value and quality (Ayana, 2010). The use of edible films in active packaging is a new approach in food safety. The necessity of simple production technology, being cheap, being obtained from natural compounds, the diversity of functional properties and the biodegradability packaging materials. Control the transfer of moisture, oxygen, carbon dioxide, lipid, flavor and aroma by serving as food transfer between food components or between the atmosphere surrounding the food (Alper, 1998). Additive materials such as preservatives and antioxidants can be added to edible films and coatings, the number of microorganisms on the surface of food can be controlled (Ayana, 2010). In addition, the environmental damage caused by the residual materials used in packaging makes alternative packaging applications attractive, With the increasing demand of consumers for reliable, high quality and long shelf life products, the use of edible films and coatings is also increasing (Janjarasskul & Krochta, 2010).

Polysaccharides films

Polysaccharides – based films and coatings are applied generally with several gums and chitosan (Sánchez-Ortega et al., 2014). The gums are allowed to dissolve in water through the hydrogen bonds that exist between solvent and polymer, In solution the polymer molecules can reorganize into different the structure is known as a micelle, which holds or strengthened with the aid of intermolecular hydrogen bonds (Dehghani, et al., 2018).The mechanical properties of the polysaccharide and the gas barrier are very good. Although they are effective against fats, their resistance to water migration is low due to their hydro-specific properties. The most important feature of the polysaccharide films is that they are structurally stable and reduce the oxygen delivery rate. These films have very low resistance to water passage (Robert, 2013). As edible polysaccharide film and coating material; cellulose ethers, starch, chitosan, pectins, algae extracts and gums are used (Gennadios, 1997; Janjarasskul & Krochta, 2010). Starch is available and the cost is very low. It is a reliable polymer for an edible film because of its thermoplastic properties (Jimenez et al., 2012). It is colorless and tasteless material derived from starchy tubers through the process of water extraction. (Nadia et al., 2014).The Incorporation of starch-based films in food packaging is favorable due to the characteristics it possess such as they are environmental appealing, low cost, flexibility, and transparency (Bilbao-Sáinz et al., 2010). Starch-based edible films are tasteless, odorless and transparent, therefore, prevent the food taste, flavor and appearance from alteration (Chiumareli & Hubinger, 2012). The major advantages of starch films are possession of good barrier properties to oxygen and carbon dioxide. contrarily, it possesses a weak barrier property to the water as a result of high hydrophilicity (Šuput et al., 2013) Starch-based films added with chitosan and lauric acid proved distinct effect to retard Bacillus subtilis and Escherichia coli showed that the film contains strong antimicrobial effect (Salleh et al., 2007).

Lipid films

Lipid compounds, The fatty acids commonly applied for this goal are waxes, nonhydrogeneted vegetable oils, fatty alcohols and fatty acids that possess carbon atom number which changes from 14 to 18 such as natural and synthetic waxes and glycerides, are used as coating material due to low polarity and good moisture barriers. In general, wax coatings are more resistant to moisture than other lipid and non-lipid coatings. Oil- based candles and films; Thickness and slippery surfaces; Application can cause problems due to wax and bitter taste (Robertson, 2013). Direct application of any lipid to a hydraulic or wet surface results in poor absorbent power between the food and film interface. So the double layer coating Barrier properties will heal (Pavlath, 2009). In the film production of lipids and lipid-based films, solvent and high temperature show poor mechanical properties. Lipids in the liquid phase show less resistance to gas and vapor passage than solids. (Dursun, 2009) Lipids are normally Incorporate along with other film-forming materials, like proteins or polysaccharides, functioning as emulsion particles or multilayer coatings in order to expand the resistance to water penetration (Mehyar et al., 2012).

Chitosan-lipid based film

Chitosan-lipid based films performed better efficiency to moisture movement when the lipid is uniformly integrated in the matrix.It also reveals the importance of the morphological organisation of the lipid within the chitosan matrix, [Wong, et al., 1992].Packaging film is assumed to possess characteristics of resisting breakage conditions that are worst, also the plastic quality of the packaging film should be able to adapt to possible malformation (Velickova, etal., 2013).

Waxes

Waxes are composed of esters of long-chain aliphatic acids with long-chain aliphatic alcohols, resulting from the low level of polargroups and elevated level of long-chain fatty alcohols and alkanes,they are strongly resistant to water movement than almost all other edible film substances (Cordeiro de Azeredo, 2012). Mono-, di- and triglycerides also possess the characteristics to be used as coating substances. The chemical structure can remarkably influence the functional properties, mostly water vapor permeability. Short-chain triglycerides are partly soluble in liquid soluble, while long-chain molecules are insoluble in water. (Dehghani, et al., 2018).

Edible films applied with cinnamon oil

Edible films applied with cinnamon oil was used to serve as an antioxidant and antibacterial coating for snakehead fish fillets (Lu et al., 2010). Cinnamon is highly consisted of cinnamaldehyde as well as b-caryophyllene, linalool and several terpenes (Wong et al., 2014). In another research by (Anvari & Rezaei, 2011) shows that a gelatin coating improved with cinnamon oil has the potential to prolong the shelf-life of fresh rainbow trout fillets whereas enhancing an acceptable quality during storage. Gelatin coatings with the inclusion of cinnamon drastically lowered total bacteria growth during 15 days of cold storage (Anvari & Rezaei, 2011). Study was also carried out on effect of chitosan-based edible coatings enhanced with garlic (*Allium sativum*) oil at 0.5, 1.0 and 1.5% on shrimp (*Parapenaeus longirostris*) quality was evaluated during refrigerated storage by (Asik & Candoğan 2014) concentration of garlic oil was reduced (0.5%) in the coating with containing chitosan, it shows to be adequate to maintain and extend the shelf-life (Asik & Candoğan, 2014).

Protein films

Proteins used for the film are polymers comprises more than 100 amino acid remnants (Hanani et al., 2014) and this protein must be modified by heat, acid, alkali and/or solvent in order to create the more enlarge structures which are needed for film formation (Bourtoom, 2008). The mechanical properties and barrier properties of the protein obtained are better than those obtained from polysaccharides and lipids. The diversity of proteins from other structural components is that various functional properties, particularly intermolecular binding potentials, are high. Protein films limit the use of low water vapor resistant areas (Campos et al., 2011). Proteins are better than polysaccharides in their potential to create films with greater mechanical and barrier effects they possess (Cuq et al., 1998).

Proteins are great substance for film formation which possess excellent gas and lipid barrier properties (Popović et al., 2012), especially at lower relative humidity. Edible protein, herbal origin proteins (eg, corn zeini, wheat gluten, soy protein, pea protein, sunflower protein, peanut protein, rice protein and cottonseed protein) and proteins of animal origin (keratin, collagen, gelatin, fish myofibrillar protein, egg flux protein, casein and whey protein) (Dursun & Erkan, 2009).

Lin et al. (2009) applied three antioxidants consisting butylated hydroxyanisole, butylated hydroxytoluene, and n-propyl gallate to produce antioxidant zein coatings. Zein coatings consisting n-propyl gallate proved the most improved quality of preservation whereas all three antioxidants caused retardation of quality degradation. Several proteins possess antimicrobial effects and have been applied with films and coating products. Proteins from lactic acid bacteria which destroy other related and unrelated microorganisms are reffered to as bacteriocins. Heat-stability, observable hypoallergenicity and simple deterioration by proteolytic enzymes in the human intestinal tract are mostly common features of bacteriocins (Sánchez-Ortega et al., 2014).

Chitosan is obtained from chitin by deacetylation with the use of alkali. Chitin and chitosan have been used several times in differents researcher in the food industry to serve as wrapper for the food because of ability of film forming they possess. Chitosan films are tough, durable, flexible and not easily pull apart with average water vapour permeability level and it could function to prolong the storage life of fresh produce and foodstuffs with higher water levels (Phadke et al., 2011). The use of chitosan in coating offers a great advantage in preventing microbial surface growth on foods. It will cause the retardation of Listeria monocytogenes growth whereas being a biopackaging (Coma et al., 2002). Chitosan was applied on glazing skinless pink salmon (*Onchorhynchus gorbuscha*) fillets. Fillets glazed incorporated with chitosan solution shows high yield than lactic acid glazed and distilled water glazed fillets and retardation of lipid oxidation after eight months frozen storage was observed (Sathivel et al., 2007).

Composites film

Edible films are diverse in nature, combining the mix of polysaccharides, protein, and or lipids. This perspective allows the utilization of definite functional characteristics of an individual class of film. currently, many scientists have broadly explored the expansion of composite films incorporated with methyl cellulose and lipid, methyl cellulose and fatty acid, corn zein, whey isolate and lipids, casein and lipids, corn zein and corn starch, gelatin and fatty acid, soy protein isolate and gelatin (Phadke et al., 2011).

Usually films made from a raw material have a good deterrent or good mechanical resistance, but they cannot show two good properties at the same time. While protein and polysaccharide films are resistant to oxygen permeability, they are hydrophilic and therefore resistant to water vapor permeability. Lipid-based films form a good moisture barrier, but the surface of these films may have pores and cracks, such as holes and pores, not homogeneous, and may produce a candle-like taste in the product. Mixtures of different materials are used to eliminate these negatives and to produce the desired film (Gennadios, 1997). Two basic methods are used in the production of composite films. One of the emulsion methods is that the two-layer films are produced by laminating the lipids onto the edible film and adding oil to the solution of the film (Robertson, 2013; Gennadios, 1997).

Active compound applied in Edible film and coating

Food additives can be integrated into edible films and coatings, these additives include anti-browning agents, antimicrobials, flavors, colorants, and several functional substances. The active properties of films and coatings should release these compounds slowly such as antimicrobials and autoxidation agents which cause retardation of food deterioration and leads to absorption of undesirable compounds (e.g., free radicals) these free radicals can speed up the rate of food degradation. The edible coating is an excellent process to incorporates the additives lowly to the seafood which results in interaction between the coating and external compounds before it gets to the surface of the fisheries products. (Dehghani et al., 2018). There are different classifications of active compounds that can be incorporated into edible films and coating which includes organic acids (e.g., benzoic, propionic, lactic, sorbic and acetic), fatty acid esters, polypeptides and bacteriocins (e.g., peroxidase and nisin); plant essential oils (e.g., cinnamon, oregano, and lemongrass) also, probiotic bacteria are commonly applied in films and coating (Dehghani et al.,2018).

The antimicrobial effect of organic acids

The antimicrobial effect of organic acids occur through concentration of the un-segregated form, which can invade the bacterial cell membrane, dissociation can occur within the cell and this results to interaction with membrane permeability (Sánchez-Ortegaet al., 2014). In a study with shrimp with the effectiveness of catfish skin gelatin-based antibacterial edible coatings which content level of 2% PS, 2% sodium tripolyphosphateora combined solution including the base solution plus 2% PS and 2% sodium tripolyphosphate on extending the shelf-life and quality changes of fresh shrimp with ice storage were studied. The results proved that the antimicrobial coating has the potential to slow down microbial growth and improve the shelf-life for up to 10 days (Jiang et al., 2011). Another study also proved that citric acid has the potential to improve enhance the preservation role of chitosan significantly through retardation of lipid oxidation and restricting microbial growth with the application of thiobarbituric acid reactive substances and total plate count, accordingly (Qiu et al., 2014).

**Application Methods of Edible Packaging**

The selection of the raw materials and other additives, the techniques applied and the thickness of the coating are effective on the final properties of the edible coating. Coating technique should be selected in such a way that the end product cannot be damaged (Işık et al., 2013).

**Immersion Method**

In this method, the products are immersed in liquid coating materials and the excess material is removed from the product for drying and solidification. After immersion, the products may be allowed to dry by standing in room conditions or by moving the solvent to a desiccant (Işık et al., 2013).

**Spray method**

The spraying method is applied by spraying to the edible coating product if a certain portion of the product is to be coated or if a uniform layer is to be obtained. This method is particularly high pressure spray applicators or air blower with the development of systems, fruit and vegetable coating is a method used (Işık et al., 2013).

**Dripping Method**

It is determined that chitosan reduces the moisture loss in prepared meatballs (Wu et al., 2001). In general, carbohydrate-based edible films and coatings are often used to improve the quality and stability of meat throughout storage and sale. Also, using edible films with low oil permeability, oil absorption of products to be fried in oil can be prevented and in this way, better nutrients and sensory properties can be obtained. In addition, some edible films have been developed which better control the ripening by reducing the oxygen penetration in the fruits and reducing the carbon dioxide and ethylene evaporation (Debeaufort et al., 1998).

## CONCLUSION

The application of non-biodegradable packaging materials in fish and seafoods industries to increase the product quality and shelf-life results to a huge environmental threat on human health and wellbeing. Biodegradable coating and films are produced from several carbohydrate and protein origin and these coating and film are safely applied for enhancement of seafood quality and to prolong their shelf life. The active packaging of fish presents a low cost alternative to conventional preservation technologies (vacuum and modified atmosphere packaging) as a result of lack of huge capital for investments, biodegradable, edible films and coatings help in the enhancement of microbiological stability of fish and drastically lower the waste; also, delay lipid oxidation. Fish is among the most-traded part of the world food sector. Wherefore, there is urgent demand for the packaging of this good in Industrial and commercial based antimicrobial production is needed.

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