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A REVIEW-FISH GELATIN BASED-EDIBLE FILM

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ABSTRACT

Increased knowledge and information about packaging materials in the community led to increased awareness of the importanceof food security, health and the environment.This triggers the demand for packaging materials that are safe for health and environmentally friendly. Packaging that can protect the products and be safe for health is edible packaging. Edible film can be formed from fish gelatin which is a hydrocolloid. Gelatin raw material can be produced from fish processing industry waste in the form of skin and bone waste. Physical properties that determine the quality and use of edible films include thickness, percent elongation and tensile strength. Thickness determines the resistance of the film to the rate of movement of water vapor, gas, and other volatile compounds.

INTRODUCTION

Packaging technology is currently developing rapidly along with the development of the food industry. Food products require good packaging to protect their products during storage, distribution and marketing. The most widely used packaging is a type of plastic packaging. Plastic packaging has many advantages compared to the other types of packaging, including flexible, not easy to tear, transparent, easily obtained at a low price and can protect the product well. However plastic has the disadvantage of being difficult to degrade when discarded, this can cause problems for the environment. Plastic waste can pollute the soil, water and air environment. Therefore, efforts should be made to develop an environmentally friendly and biodegradable.

Increased knowledge and information about packaging materials in the community led to increased awareness of the importance of food security, health and the environment. This triggers the demand for packaging materials that are safe for health and environmentally friendly. Packaging that can protect products and be safe for health is edible packaging. Edible film is one solution to reduce the use of plastic. Edible films is a thin continuous layer of biopolymer materials which can be applied as a coating on food, used as a wrap or made into pouch to hold the food to protect it against external factors like water, oxygen, carbon dioxide and lipids to enhance the storage life of the foods [1]. Edible films can serve as carriers for a wide range of food additives, including various antimicrobials that can extend product shelf life and reduce the risk of pathogen growth on food surfaces [2].

Edible film and coating in its development has long been used as a protective food product. Examples are the application of sugar and chocolate as coatings on candy, wax coatings on fruits, liquid fats or oils are also often used as coatings on food products. Edible film is also very interesting and is often used as a parameter to the quality and stability of some food products [3]. Protein-based films and coatings have superior inhibitory and mechanical properties compared to those made from polysaccharides. This advantage is due to the protein containing 20 different types of amino acids and has special characteristics so as to produce more varied functional characteristics when compared with the polysaccharides used as ingredients in making edible films which are mostly homopolymers [4]. Pprotein film-forming materials are numerous and they may be easily derived from animal and fish sources, such as collagen, whey protein and gelatin [5]. Gelatin is a protein based polymer widely used as a starting material for edible film formation. However, fish gelatin film showed poor water resistance properties [6].

The main source of gelatin which is widely researched and utilized is derived from the skin and bones of cows and pigs. But the use of pigskin is unprofitable when applied to food products in countries with a majority Muslim population. According to [7] the raw material of gelatin that was used consisted of raw material for cow leather at 28.7%, pig skin 41.4% and cow bone at 29.8% and the rest from fish. Pork gelatin is a problem among consumers who follow Kosher and Halal dietary standards and is also not permitted to be used by Muslimsand Jews for religious regions [8].

Thus it is necessary to develop gelatin from other animal sources, one of which is very prospective for development is that it comes from fish processing byproducts. The fish processing industry produces skin and bone waste which can be used as raw material for gelatin.The waste from fish filleting in seafood industry consistsof skins and bones that make up to 30% of the total waste. Films made from fishgelatin can be an effective substitute for films made from mammalianspecies [9].Several studies have been conducted on the characteristics of edible films made from fish gelatin, including tuna-fish gelatin [10]; Gelatin from skin of grey triggerfish (*Balistescapriscus*) [11]; skin cuttlefish-gelatin [5]; fish skin gelatin [12]; tilapia bone gelatin [13]; white snapper bone gelatin [14].

Fish Product Waste

Waste in general is material that is wasted or discarded from human activities and natural processes and does not have economic value, even waste has the potential to pollute the environment.The fish filet industry will produce various wastes, namely bones, leftover meat, scales, skin, and stomach contents.The waste from fish filleting in seafood industry consists of skins and bones that make up to 30% of the total waste [9].Waste of fish bones in making filet causes a buildup of waste that is not utilized. Fish bone waste can be used as a variety of materials that can be utilized.

Bone waste and skin of tilapia can be used as raw material for making gelatin. Utilization of tilapia bone as a source of gelatin is an effort that can increase the added value of fish bones, because so far the use of fish bones is still limited to making bone meal for animal feed or thrown away, even though tilapia bone has sufficient collagen content height that has the potential to be used as gelatin. Collagen in bones and skin can be extracted into gelatin through the process of adding acid or alkali treatment and the heating process causes the collagen can be converted into gelatin. The collagen content of hard fish (teleostei) ranges from 15-17%, whereas in cartilaginous fish (Elasmobranchi) ranges between 22-24% [15]. Fish bones are also a potential alternative material to replace the gelatin raw material made from mammals.

Fish Gelatin

Gelatin is a type of protein obtained from natural collagen found in the skin and bones [16]. Gelatin is a protein derivative from collagen fibers found in the skin and bones of animals. Arrangement its amino acids are almost similar to collagen, i.e. glycine as a main and amino acid 2/3 of all the amino acids that make it up, while 1/3 of the remaining amino acids are filled by proline and hydroxyproline [17]. Gelatin can be reversibly changed from sol to gel form, expands in cold water, can form films, affect the viscosity of a material, and can protect the colloidal system [18].

Gelatin is divided into two types based ondifferences in processing, namely type A andtype B. In making type A gelatin, raw materialimmersion was treated in an acid solutionso this process is known as a processacid. Whereas in making type B gelatin,the treatment applied is basic treatment.This process is called the alkaline process [19]. The complete differences in the type A and B gelatin properties are presented in Table 1.

Table 1. Differences in the Properties of Type A and Type B Gelatin[20]

Properties	Type A	Type B
Gel Strength (gram bloom)	50-300	50-300
pH	3,8-5,5	4,7-5,4
Isoelectric point	7-9	4,7-5,4
Viscosity (mps)	15-75	20-75
Ash content (%)	0,3-2	0,5-2

Fish gelatin is generally extracted from the skin and bones of fish through an acidic or basic process. The fish skin used comes from the waste of the fish filet industry. Fish gelatin can be obtained from the extraction of bones and skin of fish such as salmon, sharks, tilapia [21]. Research [22] regarding extraction of tilapia skin gelatin at a temperature of 45o C and hydrochloric acid yielded yield of 11.94%, pH 3.7, moisture content of 9.09%, viscosity of 4.13 cPs, strength of gel 140.57 bloom and fulfilled Indonesian National Standards so that they can be applied in the industrial field.

Several studies on gelatin have been conducted. Research into gelatin from red snapper skin, Red snapper skin can be used as gelatin because in it there is collagen protein. The combination of treatments that produce the best gelatin is a concentration of acetic acid 3% and a long immersion of 18 hours [23]. Furthermore gelatin can also be extracted from red snapper bones by using a strong acid solvent, namely HCl. Based on the value of viscosity, gel strength and pH,the best treatment in extracting gelatin from boneRed snapper is a 4% HCl solution for 48hours and extraction temperature of 80ºC for 6 hours [24].

Generally fish gelatin has a lower gel strength compared to mammalian gelatin, this is because the amino acid content of mammalian gelatin is higher than that of fish gelatin. Land-water fishes also have a higher amino acid content than cold-water or deep-sea fish. According to [25] that gelatin with high amino acids has a higher gel strength, melting point and gelling point, and it is also stated that the melting point of extraction from younger fish has lower gel strength. Furthermore, the application of gelatin in foodstuffs, among others, as a gelling agent, thickener, emulsifier, foam maker and edible film, in the pharmaceutical field, gelatin is widely used in the capsule industry can be made soft and hard capsules [26].

Characteristics of Fish Gelatin Based-Edible Film

Edible film is a thin layer that can be directly fed and safe for the environment because it is biodegradable [27]. Because it is environmentally friendly (biodegradable) edible film can replace synthetic packaging.Edible film has several functions, namely as an inhibitor of water vapor transfer, inhibits gas exchange, prevents loss of aroma, prevents fat transfer and enhances physical characteristics [28]. Water content in food is the most important point in maintaining food freshness, controlling microbial growth and maintaining food texture. Edible film can also function as a food container or small bag, packaging, separating layer on heterogeneous food products and nutritional supplement carriers, for example on protein-based films can improve nutrition to food, but depending on the quality of the protein [1].

The basic ingredients of making edible films can be divided into three groups, namely [29]:

1. Hydrocolloid

   In making edible films, hydrocolloids used are protein and carbohydrates. Carbohydrate-based films are in the form of starch, gum (alginate, pectin, and Arabic gum) and chemically modified starch. Whereas protein-based films usually use gelatin, casein, wheat gluten and corn protein. The use of hydrocolloid in edible film material is very good, because it can inhibit the transfer of oxygen, carbon dioxide and fat and has excellent mechanical characteristics, so that it can improve the structure of the film so it is not easily destroyed.

2. Lipids

   Lipid-based films are usually used for moisture retardants or coatings to make gloss on candy products. Lipids that are often used in film making are waxes, fatty acids, monoglycerides and resins [28]. Lipids are added to edible films due to their hydrophobic properties [29].

3. Composite

The components of the composite film are lipids and carbohydrates. The application of a composite film in the form of a one-on-one (bilayer) layer, where one layer is hydrocolloid and another layer is lipid, or can be a combination of lipid and hydrocolloid in one film unit. The advantage of using lipids is that they are resistant to water evaporation, while the benefits of hydrocolloidcan provide durability. Combined films consisting of lipids and hydrocolloids can be destined to coat fruits and vegetables [29].

Edible films made from hydrocolloids have good mechanical properties, but are not efficient as a moisture barrier because they are hydrophilic. To overcome this problem in making edible film often added plasticizer material. Plasticizer is a low molecular weight organic material that is added with the intent to weaken the tightening of the polymer and increase flexibility. The physical characteristics of edible films are influenced by the type of plasticizer concentration used [30]. According to [31] plasticizer glycerol and sorbitol are plasticizers of the polyhydric alcohol or polyol group.

Physical characteristics measured and observed from edible film packaging are thickness, tensile strength and percent elongation. These parameters can explain how the physical characteristics of film material are related to their chemical structure. Physical characteristics show the integration of the film when experiencing stress that occurs during the process of forming the film.The quality of edible films can be seen from one of its characteristic characteristics, namely physical properties. Edible film quality must have the same properties as plastic packaging, which has a transparent color so as not to affect the authenticity of the color of the product being packaged. In addition good edible film has good elasticity and flexibility, low fragility, strong, and does not crack during storage.

Physical properties that determine the quality and use of edible films include thickness, percent elongation, and tensile strength. Thickness determines the resistance of the film to the rate of movement of water vapor, gas, and other volatile compounds. Edible films are relatively resistant to oxygen and carbon dioxide transfer, but are less resistant to moisture [32].

Several studies on the development of edible film based on fish gelatin have been carried out and with some modifications.Edible film can be formed from white snapper gelatin. The best edible film characteristics were produced by the addition of 10% gelatin with the results of transparency 1.10 - 1.22,thickness 0.22 - 0.38 mm, tensile strength of 8.87 - 12.24 Mpa and percent elongation of 13.5 - 22, 5% [14].The edible films made from tuna-fish gelatin with antioxidant extracts oftwo different murta ecotypes leaves (*Ugnimolinae*Turcz) are transparent andshow acceptable mechanical properties and barrier propertiesto water vapour and UV light. When using an extract with a bigger content ofpolyphenols, like the Soloyo Chico ecoptype, the antioxidantcapacity of the film increases, but the mechanical properties decreases, due to a greater interaction betweenpolyphenols and proteins [10].

The physicochemical, thermal and mechanical properties of blood orange peel pectin (BOPP) film blended with fish gelatin (F-G), was found to reduce the wettability of the gelatin film, whereas it slightly reduced its transparency. F-G:BOPP film prepared with equal ratios (50:50) showed the highest glass transition temperature (Tg ~ 79 ^{o}C) and tensile strength (TS ~ 14 MPa). The F-G:BOOP wrapping improved the physicochemical and the textural properties and the microbial stability of cheese during chilled storage [11].

Fish gelatin edible films was plasticized with 20% and 25% glycerol (w/w of gelatin) and developed by twin-screw extrusion at 110 and 120^{o}C followed by compression molding at 80^{o}C. The films extruded at 110^{o}C and with 25% glycerol had the highest percent elongation at break of 293 ± 27%. The water vapor permeability values of extruded films (the highest value being 2.9 ± 0.2 g mm h^{-1} cm^{-2} Pa^{-1}) were higher than those of solution-cast films while the glass transition temperatures (Tg) of the extruded films were generally lower than those of solution-cast films. The higher percent elongation (%E) of extruded films over solution cast films makes them suitable for potential application as food wraps [33].

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