Fish Skin Waste: Increased Value Added And The Application (a Review)

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ABSTRACT

Processing of fishery resources, especially fish, has not been optimally carried out until the utilization of fishery waste, such as heads, bones, scales, and skins. Along with the development of the fishing industry, the waste generated from the company's production also increases. Fish processing businesses almost always produce waste in the form of solids (bones, scales, skin, head) and liquids which directly or indirectly will have an adverse impact on the environment because it causes pollution. This waste is of very low value but if used optimally it will provide significant added value. Fish skin waste can be used to produce several products that have added value. Some of the products resulting from the utilization of fish skin waste from the processing of fishery products are fish oil, skin crackers, leather tanning, collagen and gelatin. Fish skin crackers are one of the diversification of fishery products. The results of fish skin tanning can be applied as raw materials in the manufacture of bags, wallets, belts, jackets, and souvenirs. Gelatin applications can be made as a gelling agent, emulsifier, clarifier and coating in food products.

Keyword: *Fish skin, Waste, Gelatin, Collagen, Tannery, Fish skin crackers*

1. INTRODUCTION

Abundant fishery products have good enough potential to be utilized. Fish is a source of food that contains nutrients that are beneficial to the body. These benefits include being a source of energy, helping the growth and maintenance of the body, strengthening the immune system, facilitating physiological processes in the body. The advantages of fishery products are that they contain high enough protein (20%) in the fish body, protein also functions as fuel in the body [1]. Protein in fish contains the composition of amino acids needed by the human body, besides that in fish there are essential unsaturated fatty acids and other nutrients needed by the body as well as sources of vitamins, especially vitamin A and mineral sources such as iron, iodine, zinc, selenium and calcium are all closely related to deficiencies of micronutrients [2].

Processing of fishery resources, especially fish, has not been optimally carried out until the utilization of fishery waste, such as heads, bones, scales, and skins. Along with the development of the fishing industry, the waste generated from the company's production also increases. Fish processing businesses almost always produce waste in the form of solids (bones, scales, skin, head) and liquids which directly or indirectly will have an adverse impact on the environment because it causes pollution. This waste is of very low value but if used optimally it will provide significant added value.

Fish skin contains 69.6% water, 26.9% protein, 2.5% ash and 0.7% fat [3]. [4] stated that approximately 80% of the dry matter of the skin consists of various kinds of proteins and very complex compositions. Proteins in the skin can be divided into two major groups, namely (1) proteins belonging to protein fibers including collagen, keratin, and

elastin; (2) proteins classified as globular proteins include albumin and globulin. Fish skin waste has high added value because it can be used as raw material for the manufacture of collagen and gelatin. Fish skin is very potential as a material for making gelatin because it covers 10-20% of the body weight of fish [5].

1. WASTE SOURCE

Fish waste such as fish bones and skins that have not been utilized can pollute the environment with a strong odor. Fish skin waste can be used to produce several products such as gelatin, fish skin crackers, and tanning. Some sources of fish skin waste are as follows:

- Tuna Fish Skin.

Tuna skin waste can be used as raw material for making fish gelatin. Tuna that is exported to other countries from North Sulawesi is in the form of tuna loin. Exports of large fillets can produce by-products in the form of tuna skin waste which is estimated at 12% so that the amount of gelatin obtained will also be large [6].

- Tilapia Fish Skin.

Tilapia exports from Indonesia are generally in the form of fillets. One of the by-products of processing tilapia fillets is fish skin. Tilapia skin waste can be used as raw material for crackers and tanning which have a high selling value and can be exported to other countries [7].

- Pangasius Catfish Skin.

Catfish skin can be used as an ingredient for making gelatin and crackers. The fish skin used comes from industrial waste processing fish fillets [8]. Fish skin waste that can be generated is 4% [9].

- Milk shark skin.

The level of utilization and development of milk shark skin in Indonesia is limited to leather tanning into leather industrial goods, so it is necessary to develop other products that can meet the needs of the food and non-food industries, one of which is the development of gelatin [10].

- Skin of Mackerel, White Snapper, Stingray, Catfish and Milkfish.

Fish skin waste can generally be obtained from the rest of the processing of fish meat, such as leftovers from making fish crackers, fish balls, fish meal, shredded fish and fish sauce. Mackerel fish skin can be used as fish skin crackers [11].

2. FISH SKIN WASTE HANDLING

The forms of products resulting from the utilization of waste from the processing of fishery products are quite diverse, including:

1. Fish oil

Fish oil can be produced from the remains of fish meat and skin. Processing by extraction, with a combination of cooking, drying, and pressing to separate the oil and fish meal. The health benefits of fish oil can prevent several diseases, including coronary heart disease, excess blood cholesterol, cancer, hair loss, and for immunity.

2. Collagen and gelatin

Collagen is an important protein that connects cells to other cells. Fish skin is one of the main sources of collagen. Collagen production can be done through conventional or enzymatic extraction. The uses of collagen include food supplements, cosmetics, and additives in food and soft drinks. Meanwhile, gelatin is a protein derivative from collagen fibers found in fish skin which is obtained through the hydrolysis process of collagen fibers. Useful for food processing (stabilizer, gelling, thickener, emulsifier, adhesive, edible coating, water binder), and non-food (cosmetic, medical/pharmaceutical, paper, etc.).

Various studies of making gelatin using the skin of various types of fish have been carried out, including research conducted by [12], namely by utilizing the skin of yellow fin tuna which produces a yield value of 17.00%. The manufacture of gelatin using red snapper skin has also been carried out by [13]. Tuna is a type of fish that contains very high protein [14].

The yield value of the gelatin obtained from the three methods was calculated, and the gelatin with the best yield value was continued for characterization, which included tests for water content, ash content, fat content and functional group analysis using FTIR (Fourier Transform Infra Red). The stages of making gelatin begin with a

pretreatment process, such as degreasing (soaking using hot water at a temperature of 60-70◦C for 1-2 minutes so that the remnants of meat and fat and other adhering impurities can be removed) and demineralization (removing minerals from the body). Tuna skin so that gelatin extraction can be carried out.). After the demineralization process, the skin that has been treated with demineralization is washed with running water to remove the HCl solution that is still attached, this washing is carried out until the pH becomes neutral (6-7) because the pH produced with HCl solution will produce type A gelatin with a pH point of (7-9).

3. ALTERNATIVE FISH SKIN WASTE HANDLING

The forms of alternative products resulting from the utilization of waste from the processing of fishery products are quite diverse, including:

1. Fish skin wallets can be produced from the tanning process of various kinds of fish, including stingrays and tuna. Processing by cutting the skin, smoothing the skin with sandpaper, making patterns, to gluing and sewing. Stingray wallets are quite popular because of their uniqueness and high artistic value.
2. Fish skin jacket
3. Fish skin shoes

The three products above are the result of tanning various types of fish, but the most commonly used are stingrays and tuna. The stages of the tuna skin tanning process are as follows: liming, lime removal and protein scraping, acidification, chrome tanning, neutralization, curing, re-tanning (mimosa treatment 5%, 10% and 15%), base painting and oiling, stretching, moisturizing , re-stretching and ironing. After that, the tanned skin was subjected to a physical analysis which included tests of tensile strength, tensile strength and tear strength.

The leather products from several types of fish are then processed again to be made into wallets, jackets, shoes, and other products. The tanning process usually uses the help of tanners, including vegetable tanners, mineral tanners, synthetic tanners, and oil tanners. One example of the plant used is the mimosa plant [17].

The results of the tensile strength analysis showed that the use of mimosa gave a significantly different effect on the tensile strength of tanned tuna skin. The greater the concentration of mimosa used, the value of the tensile strength will be even greater. The results of the tensile strength analysis showed that the use of mimosa gave a significantly different effect on the tensile strength of tanned tuna skin. The greater the concentration of mimosa used, the value of the tensile strength will be smaller. The results of the tear strength analysis showed that the use of mimosa had a significantly different effect on the tear strength of tanned tuna skin. The greater the concentration of mimosa used, the value of the tear strength will be even greater [17].

4. PROCESSING OF FISH SKIN WASTE AND ITS PRODUCT

5.1 Gelatin from Yellowfin Tuna (*Thunnus albacares*) Skin

Gelatin is a type of protein extracted from animal collagen tissue. In animals, collagen is found in bones, skin and connective tissue. Gelatin was first discovered by a Frenchman named Papin in 1682. This discovery later developed and became one of the industrial materials used for various purposes and currently the use of gelatin is increasingly widespread, both for food and non-food products [18]. For food products, gelatin is widely used as a stabilizer, gelling agent, binder, thickener, emulsifier, adhesive and edible coating. While in non-food products, gelatin is used in the engineering industry, cosmetic industry, photography industry, pharmaceutical and medical industries [19]. Fish skin and bones are parts that contain collagen which can be converted into gelatin [20].

Basically, the process of making gelatin there are two ways, namely the process using an acid and a base. The difference lies in the immersion stage. The selection of acid, alkaline or other extraction methods will affect the gelatin yield to be obtained, this also applies to the selection of treatment at the time of extraction carried out such as the selection of the extraction time or duration of the hydrolysis process, the use of pH, the level of concentration and the type of solvent as well as the temperature at the time of extraction will affect the hydrolysis reaction that occurs. In this study, strong acid HCl was used to hydrolyze collagen into gelatin from tuna skin (*Thunnus* sp).

According to [21], hydrolysis using acid is preferred over the alkaline process because it will be more economical and effective. This is because the process of soaking in acid is relatively shorter than the process using base. Skin

soaked in strong acid will be hydrolyzed, so that the protein in the form of collagen in the skin will be denatured, this causes the change of collagen fibers that are not soluble in water to become soluble and easily digested, which is known as gelatin. Acid concentrations that are too high can cause collagen that has become a single chain to dissolve during the rinsing stage, so that collagen will also be wasted. According to [18] an acid concentration that is too high causes damage to collagen, so that collagen cannot be converted into gelatin.

5.2 Crackers from Fish Skin

Fish skin crackers have a very delicious taste, not much different from beef skin crackers which contain high nutritional values such as protein, fat, minerals, calcium, phosphorus, water and energy. The quality of fish crackers is determined by many things, not only related to the process of processing the fish skin into fish skin crackers, but also influenced by the fish processing process to produce waste in the form of fish skin. Poor handling during the processing can produce fish skin with poor quality, for example, it has a bad smell (rotten) and some tastes bitter due to bile contamination. This condition will be carried over to become a skin cracker product [11]. Several factors that affect the quality of fish skin crackers include [22] as follows:

1) Appearance: includes physical condition, uniformity of shape and size and packaging.
2) Taste : a distinctive and delicious taste will appear if at the time of making fish crackers the appropriate spices and ripe acid are added which serves to eliminate the fishy smell.
3) Cooking Oil : to avoid rancidity, it is recommended to use factory-made cooking oil which is produced in a modern manner so that it is more durable.
4) Durability: the durability (durability) of fish skin crackers, whether stored raw or cooked, is influenced by the water content in them.

The procedure for making fish skin crackers consists of several stages, including [11]:

l) Stage of preparation of hardener and raw materials
   a. The hardener is principally made by dissolving whiting or limestone or quicklime in water continuously for 7 (seven) days until it becomes a soft lime slurry.
   b. Raw material in the form of fish skin that is still "dirty", that is, that is still mixed with some other fish parts (fins, tail, entrails, spines, or heads) must be separated from these parts and selected with good quality.
   c. After that cleaned with water until completely clean and drained. Raw material from fish skin waste that has been temporarily preserved or dried must be soaked for a while until it becomes wet and then it can be processed.
   d. Clean fish skin waste needs to be sanitized to avoid contamination by microorganisms by using a 0.2596 (w/v) chlorine soaking solution for 1 minute. It is then cleaned several times with water until the chlorine smell from the chlorine is gone, then drained.
   e. The hardening process is carried out with a solution of whiting for 1-2 hours so that the fish crackers will have a stiff, crunchy texture and are not easily mushy. For 10 L of soaking water, 10 tablespoons of whiting water are needed.
   f. After the hardening process, the fish skin is washed again with water until the smell of lime attached to the fish skin is completely gone, and drained.
   g. After draining the hard fish skin is dried. The dried fish skin is ready to be processed.
2) Processing stage
   a. The dried fish skin is cut with scissors to uniform the shape and size, as well as to separate other parts of the fish that may still be caught, such as fins, tail, spines, and others.
   b. Then soaked in the seasoning solution for 5-10 minutes, then removed and drained.
   c. The fish skin that has been seasoned is dried in the sun until it is completely dry. At the time of drying should be inverted so that it dries completely evenly. Once dry, it can be fried immediately or stored in a plastic bag.

5.3 Fish Skin Tanned

Several studies of fish skin tanning have been carried out by [23], conducted research on fish skin tanning for handicraft products, accessories and shoes. [17] conducted a study on the tanning of tuna skin (*Thunus* sp) using

acacia bark (*Acacia mangium*.W) on the physical quality of leather products. The leather is also used for handicrafts. However, for garment products, special requirements are required, including being weak, which is influenced by the fatliquor material used [24] is strong and can be washed without changing its appearance or physical properties. With special tanning technology, fish skins can produce finished skins that can be used as garment products so that later it is hoped to be able to create jobs for leather industry craftsmen who were forced to stop their business due to limited raw materials. The following is an example of the procedure for processing fish skin into bush skin using tilapia skin waste [15]:

1) Wet Process (Beam House Operation)
Salted tilapia skin after weighing. Followed by soaking using a solution of sodium bicarbonate and tepol for one hour, then removing the meat using a knife. After weighing, it is continued with the process of calcifying and removing scales by soaking in a solution of lime one night and scraping the scales and removing the remnants of meat that are still there. After being weighed, the lime removal process, protein and fat scraping was carried out by immersing in a solution in water, NaCl, (NH4) SO4, drug 5B and 4 2 degreasing ND. The acidification process was continued using water, salt, GS catalyst, formic acid, sulfuric acid, ND degreasing with stirring for about 3-4 hours. The final result of this process is pickle skin [25].

2) Tanning Process
The pickle skin is weighed to determine the weight of the chemicals used, then soaked while stirring in a solution consisting of water, salt, formic acid, chromosal B, sodium acetate, sodium bicarbonate, for 10 hours, followed by a retanning process using a solution water, sodium formate, sodium bicarbonate, Relugan RE, Basyntan AN and Pelan HGW let stand overnight. After washing the skin, neutralization was carried out using a solution of sodium formate and sodium bicarbonate in water temperature, 40^{o}C, then painting was carried out using a reactive dye Lugafast black AN, the pH of the solution was made 9-10 using sodium carbonate. After washing, the pH was adjusted to 5.9 and continued with the oiling process using Imergan A fatliquor and water repellant desodrin OF combined with anionic fatliquor lipoderm liquor LA and Lipoderm liquor LA and paramite MI-N and the pH of the solution was made 3.3 with formic acid. Then fixation was carried out with freshly washed chromitan B. Then drying and loosening is done and then stretched [26].

3) Testing
Testing before and after washing is carried out at the accredited Testing and Certification Laboratory of the Center for Leather, Rubber and Plastics which has been accredited with various tests: ductility, tear strength, sewing strength, tensile strength and elongation, color resistance (sweat and washing) and dimensional changes.

5. FUNCTIONS AND APPLICATIONS OF PRODUCTS PRODUCED FROM WASTE FISH SKIN

a. Gelatin

1. Ice cream
   The function of gelatin in making ice cream is that it can replace the high calories in ice cream, and as a stabilizer [6].
2. Photoresist
   The function of gelatin in this photoresist is used to extend the shelf life of the photo. In the photographic process it is better to use fish gelatin, because gelatin has a high gel strength and is sensitive to light in photo applications that are actively coated, therefore with gelatin from fish it has the direct advantage of being able to be used without complicated treatment in its application, and can be used in the same container for several days of use [6].
3. Jelly candy
   The function of gelatin in the manufacture of jelly candies, namely as a gelling agent, emulsifier stabilizer, thickener, clarifier, water binder, coating and emulsifier. Gelatin is not soluble in cold water, but if it is in contact with cold water it will expand and form large bubbles [6].

b. Leather tanning

The function of fish skin in the manufacture of tanned is as a raw material, which will later become derivative products such as bags, wallets, jackets and souvenirs. Selection of fish skin as an internal ingredient industrial

manufacture, especially the manufacture of handicrafts in the form of tanned, because fish skin has physical and mechanical properties similar to conventional leather [15].

c. Fish Skin Crackers

Fish skin in the manufacture of crackers as a raw material, a fairly high source of protein, for example made from the skin of catfish, catfish, tilapia, and mackerel. Fish crackers are the easiest fish skin waste treatment because the processing is easier and faster than gelatin processing and tanning. Fish skin crackers have a savory and delicious taste so they are liked by the wider community.

Physical results of gelatin made using tuna skin raw materials are like texture, color and smell. The texture of gelatin obtained through the acid process has a slightly rough and irregular texture with a black color. Color is one of the most important parameters, where in general the color of gelatin is expected to be white, because high-quality gelatin is usually colorless. The whiter gelatin the better, so it can be applied more widely. The brightness of gelatin is determined by the raw material and the process of making gelatin. The color of the gelatin is also related to the effectiveness of the pretreatment process, namely the release of pigment during the soaking process [16]. Parameters that are important in the manufacture of gelatin include yield, proximate analysis (protein content, fat content, ash content, water content), and functional group analysis (FTIR).

7. CONCLUSION

Fish waste such as fish skin that has not been used can pollute the environment with a strong odor. Fish skin waste can be used to produce several products such as gelatin, fish skin crackers, and tanning. Some sources of fish skin waste are tuna skin, tilapia skin, catfish skin, shark skin, mackerel skin, white snapper, stingray, catfish and milkfish. The forms of products resulting from the utilization of waste from the processing of fishery products such as fish oil, leather tanning, collagen and gelatin.

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