Review Article

Utilization of Fish Scales For Non-Food Products : A Review

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ABSTRACT

This article aims to review the use of fish scales to be processed into non-food products either directly or indirectly. Fish scales are residual waste that can be obtained from waste created in fish sales or fish processing companies. This type of waste has the potential to be utilized because it contains a variety of organic proteins that can be reprocessed to become new products. Some processed products that utilize fish scale waste include handicraft products, including brooches, *beads* (sequins), products from collagen extraction including fish glue and products from fish scale chitosan, including bioplastics, biocoagulants, and rhodamin B dye adsorbents. The importance of utilizing fish scale waste is that it can increase the selling value of fish scales which were once just waste into potentially useful materials, reduce environmental pollution, encourage the concept of a green economy, and create a *zero waste* environment in the fishery product industry.

Comment [H1]: Organic protein? Or organic materials?

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Keywords: Bioplastics, Biocoagulants, Crafts, Zero waste, Absorbent.

1. INTRODUCTION

Fish scales include waste that has not been optimally utilized. Fish scale waste is produced from the fishery processing industry such as the fish fillet industry and the whitefish processing industry. Waste has a negative impact on the environment if it is not treated properly, including fish scale waste. The negative impacts of waste that can be felt by humans and the environment, namely: a) Can cause disease in humans. b) Can spread toxic gases such as sulfide acid (H_2S), ammonia (NH_3), and methane gas to the environment due to decay with the help of microorganisms. c) Low public health which has an impact on increasing financing for treatment. d) Rising cost of water treatment.

Wasted fish scales can still be utilized because many chemical compounds are contained in fish scales which consist of, 41-84% are organic proteins (collagen and ichtylepidin) and the rest are mineral residues and inorganic salts such as magnesium carbonate and calcium carbonate. Fish scales contain nutritional components, including 70% water, 27% protein, 1% fat, and 2% ash. Protein is the largest component in fish scales [1].

According to [2] Fish scale waste needs to be used for the following reasons, namely: 1). Increase the monetary value of fish scales from what was once just waste to potentially useful materials. 2) Encourage the concept of green economy and blue economy which aims to streamline the utilization of natural resources by producing more derivative products and

other related products. 3) Creating a zero waste environment in the fishery product industry. 4) Reducing environmental pollution. This article aims to review the use of fish scales to be processed into non-food products either directly or indirectly.

2. UTILIZING FISH SCALES FOR CRAFT PRODUCTS

A craft product is a work of art created from skilled hands, it is also a symbol and cultural identity that is priceless. Fish scales can be made as materials for craft products such as brooches, *beads* (sequins), keychains, and decorations such as rose and flower basket decorations.

Brooches are accessories made for women's clothing. The way the brooch is made is as follows: Fish scales are cleaned with water and then dried at room temperature (27°C). The next stage is that the dried fish scales are colored by painting with spray paint, then the scales of the snapper are arranged to resemble flowers and given a pin on the back [3].

Fish scales can be made into *beading* raw materials (sequins), which is a type of bowl commonly used to form flower petal formations. The reason why fish can be used as raw material for sequins or beads is because of the sturdy shape of the fish scales is not easily broken and can be positioned as desired, either standing, tilted, face down or on it's back.

The method of making sequin products made from fish scales can use surface textile techniques, temple techniques, *jelujur* sewing technique, and border technique. Generally, the border technique is widely used because of the orderly arrangement and beautiful results [3].

3. UTILIZING FISH SCALES FOR ADHESIVE MATERIALS (GLUE)

Fish glue is an adhesive material derived from the extraction and hydrolysis of collagen, one of which is from fish scales. Glue comes from the decomposition of collagen, which is a large number of long-chain proteins. Collagen is insoluble in water, but it can be decomposed by heating in water, as well as other chemicals (acidic or alkaline substances).

According to both [4] and [5] the stages of making glue (adhesive material) from fish scales are as follows: Fish scales are thoroughly washed with water, then soaked in a 0.1 M NaOH solution with a 1:8 weight of fish scales to NaOH solution. Soaking is carried out for 6 hours and every 3 hours the used NaOH solution is replaced with a new one. After soaking, the fish scales are washed until it reaches a neutral pH level. The next stage is carried out the extraction process, namely fish scales are boiled in a 5% acetic acid solution for 4 hours with temperatures at 65-70ºC. Extraction results are filtered and cooled to room temperature, then concentrated with a rotary evaporator until concentrated.

Fish scale glue can be used in the paper and wood industry. This type of glue is soluble in water, non-flammable, and non-toxic to humans. Fish scale glue type products have been circulating in Indonesian society for quite some time.

Comment [H3]: Please rephrase

Comment [H4]: This section can be more comprehensive. Needs to added with figures or characteristics of the end products.

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4. CHITOSAN FROM FISH SCALES FOR BIOPLASTICS, BIOCOAGULAN, AND RHODAMIN B DYES ADSORBENTS

Fish scales contain chitin, if deacetylated, will become chitosan. Chitosan is a biopolymer that can be used as a material for bioplastics, biocoagulants and an adsoben for rhodamin B.

Chitosan from fish scales is obtained by means of three processes, namely the process of demineralization, deproteination, and deacetylization. The deproteination process is a process that aims to eliminate the protein content in the raw materials used. This process uses an alkaline solution, often is NaOH. In the deproteination process, the protein will be released and will bind to the Na^+ of NaOH to form a solution of sodium proteinate. The demineralization process aims at eliminating mineral content. In demineralization with alkaline solutions, the process often used HCl. Minerals in the raw material will combine with Cl ions to form mineral salts. Fish scales generally contain the main minerals, namely $CaCO_3$ and $Ca_3(PO_4)_2$. The demineralization process is characterized by the presence of CO_2 gas bubbles during the process. After going through the process of deproteination and demineralization, the final product is formed, namely chitin. The chitin that has been formed is then processed to obtain chitosan through the deacetylization process. The deacetylization process aims to break the acetyl bond ($-COCH_3$) in the acetamide group into an amine group ($-NH_2$). The deacetylization process uses a high concentration of NaOH alkaline solution. The OH group on NaOH will enter the chitin and will make the acetyl group detach so that chitosan is formed.

Bioplastics are alternative packaging from plastics that are more easily biodegradable by the environment. In Indonesia, the manufacture of bioplastics uses starch as a base material because of its abundant supply. According to [6] starch-based bioplastics are less waterproof, weaker *tensile strength*, stiffer, and more perishable than ordinary plastics. In order for bioplastics to remain a valid alternative to plastic, any of these weaknesses need to be corrected. According to [7] a suitable material to be added to bioplastics from starch to overcome these weaknesses is chitosan.

Chitosan is a biopolymer derived from chitin. Chitosan has hydrophobic properties, is non-toxic and also biodegradable. According to [8], the addition of chitosan in the manufacture of bioplastics will result in more hydrogen bonds so that it will make bioplastics have stronger properties. Furthermore, the addition of chitosan will also make bioplastics have good water resistance properties.

Bioplastics can be prepared by dissolving 2 grams of chitosan into 25 mL of 1% acetic acid while being heated until it reaches 60°C. Such mixing is carried out for 1 hour while stirring throughout. Then, the temperature is maintained at 60°C and then added 1 mL of sorbitol and then stirred for 15 minutes until it is thick enough. The resulting solution is then poured on to aluminum foil, glass containers, and cement molds which are then veneered at 60°C until the plastic solidifies.

The use of bioplastics can be used as packaging for electronic products, packaging in the retail industry, use in the textile industry, replacing plastic pipes, and much more. The use of bioplastics has the potential to reduce the production of existing plastic waste.

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Biocoagulants are natural coagulants that play a role in the sedimentation process of small particles that are difficult to settle on their own. Biocoagulants function as binders for dirt or particles contained in water [9]. One of the biocoagulants used is chitosan.

Research has been conducted by [10] using chitosan as a coagulant in the treatment of river water polluted with tofu industrial waste. The chitosan is extracted from fish scales. The application of chitosan as a biocoagulant is carried out by the Jartest Flocculator SW1 (Stuart Scientific) method using a stirrer or flocculator device [11]. The coagulation–flocculation process is carried out by: adding tofu waste to the chitosan solution and then stirred to form the coagulants that are ready to be separated.

Chitosan application is also used to absorb rhodamin B dyes. One of the dyes most widely used in the textile industry is Rhodamin B. Rhodamin B is a dangerous compound if it enters the body due to its chemical properties and heavy metal content [12]. Rhodamin B is a compound that has been shown to be carcinogenic to test animals with oral LD50, mice of 887 mg/kg (BPOM 2008).

One efficient method to deal with industrial waste problems, especially the removal of dyes that is currently widely developed is adsorption. The adsorption method can use a wide variety of adsorbents such as activated carbon, zeolite, bentonite, and chitosan. The use of fish scale chitosan as an adsorbent of Rhodamin B dye can reduce environmental problems caused by waste that occur such as water quality pollution, unpleasant odors, and an increase in bacteria around the disposal area

5. CONCLUSION

Fish scales are residual waste that can be obtained from waste from fish sales or fish processing companies. This type of waste has the potential to be utilized because it contains a variety of organic proteins that can be reprocessed to become new products. Some processed products that utilize fish scale waste include handicraft products, clothes brooches, *beads* (sequins), products from collagen extraction such as fish glue and products from fish scale chitosan, including bioplastics, biocoagulants, and Rhodamin B adsorbents. The importance of utilizing fish scale waste is that it can increase the monetary value of fish scales which were once just waste into potentially useful materials, reduce environmental pollution, encourage the concept of a green economy, and create a zero waste industry in the fishery product industry.

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Comment [H13]: At least 50 references

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