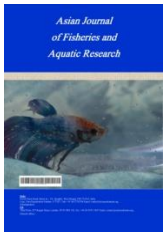

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Utilization of Fishbone for Non-Food Products

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Fishbones contain compounds that are very useful so it is important to be extracted or processed into a product. The more useful the product is for human needs, the more valuable it will be. This article aims to review the use of fishbones into non-food products. Based on the results of a review of published articles, fishbones can be used for non-food products. These non-food products are organic fertilizers, gelatin to be applied to non-food products, hydroxyapatite, glues or adhesives, accessories and lotions or skin moisturizers.

Keywords: Gelatin; fertilizer organic; hydroxyapatite; glue; accessories.

1. INTRODUCTION

Based on data from the Ministry of Industry (2019), the fish processing industry in Indonesia is growing very rapidly, almost every province has a fish processing factory. There are 616 factories that process various types of fish into food variants throughout Indonesia, such as fish fillet, surime, canned fish, drying fish, fish meal, fish crackers, and so on. This fish processing factory or industry has the potential to produce waste [1].

Fish processing industry waste can be defined as material left over and wasted from a fishery product processing industry activity. Based on its

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physical properties, fish processing industrial waste can be grouped into two main groups, namely liquid waste and solid waste. Liquid waste is in the form of liquids that are wasted from the stages of processing activities such as at the weeding and washing stages. Meanwhile, fishery solid wastes include offal, fins and tails, bones, scales, and other pieces of fish meat. Solid waste is the largest contributor to the overall fisheries industry waste.

The body part of fish that is commonly consumed is meat (49-60%). While other parts such as the head (13-19%), skin (3.5-5%), bones (7.5-12.5%), fins (2-4.5%), scales (2.5-4%), gills and entrails of fish (7-13%) are included in the fish processing industry waste. If there is no further handling of the waste from the fish processing industry, it will build up and impact the environment and human health.

Fishbones contain calcium, phosphorus, carbonate, and protein [2]. According to Beatricx and Fadilla (2011), bone contains inorganic and organic components. The inorganic components contained in fish bones include calcium, phosphorus, bicarbonate, citrate, magnesium, sodium, and others. The main organic component contained in fish bones is protein [3]. Collagen is a protein found in many body tissues, skin, connective tissue, and bones. Collagen is also a structural protein of the body. According to Nurilmala (2010), in fish bones there is 18.6% of collagen from 19.86% of complex protein organic elements. Collagen protein has a high selling value because it can be used as raw material for making cosmetics, gelatin and adhesives [4]. Meanwhile, non-collagen proteins have an important role in the mineralization process [5].

Fishbones as waste from the fish processing industry can still be used as value-added products. The more useful the product is for human needs, the more valuable it will be. This article aims to review the use of fishbones into non-food products.

2. UTILIZATION OF FISHBONES FOR ORGANIC FERTILIZER

Fish bones have the potential to be used as raw materials for organic fertilizer. Fish bones have a very high content of calcium and phosphorus. Both of these elements are macro elements that are needed by plants.

The procedure for making organic fertilizer from fish bones is:

According to Raden (2019), the use of fertilizer from fish bones has many advantages. Some of its advantages are A) The nutrients produced are clearly more complete than inorganic fertilizers. B) When applied to ornamental plants, it can make the leaves shiny, the flowers produced are even more and the strength of the plant lasts longer. C) Raw materials are very abundant, low cost, and more environmentally friendly.

3. UTILIZATION OF EXTRACTING GELATIN FROM FISHBONES

Gelatin is a type of protein produced from the hydrolysis of collagen. Collagen can be found in bone, cartilage, skin, and connective tissue from animals [6]. Gelatin is a protein derivative of collagen fibers found in skin, bone and cartilage and has an amino acid composition that is almost similar to collagen.

The process of extracting gelatin from fish bones consists of several stages including the degreasing process, demineralization process, extraction process, and drying. The process carried out in making gelatin from fish bones is:

According to Santoso et al. [7], during the soaking process in this acid solution, there is also swelling of the bones so that the collagen is easy to come out later during extraction [8]. Determination of acid concentration and immersion time needs to be done properly because it can cause damage to collagen so it affects the amount of gelatin yield produced. After the demineralization process, the fish bones were washed with water to a neutral pH.

The use of gelatin is currently quite wide for both the food and non-food industries. The use of gelatin in the non-food industry can be applied to various fields including pharmaceutical, medical, cosmetic and packaging industries. The use of gelatin in the pharmaceutical field is as a material for making capsule shells. According to Junianto et al. [9], the use of tilapia bone gelatin in capsule shells met the requirements for good physicochemical characteristics but not with flexibility properties [10]. Research on the manufacture of gelatin from fish bones has been carried out from various types of fish including stingray [11], snapper [12], catfish, tuna, and tilapia.

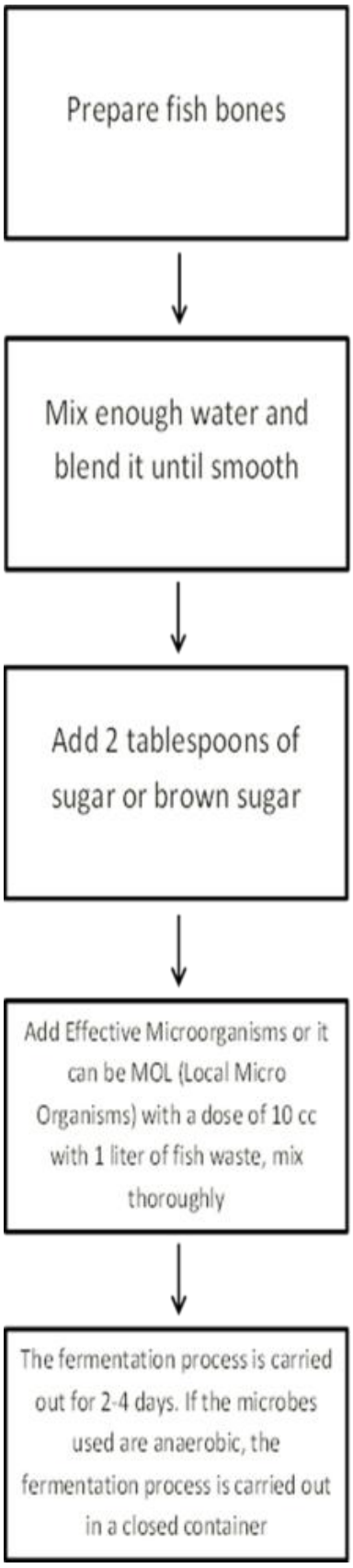

Fig. 1. Flowchart of making organic fertilizer from fish bone

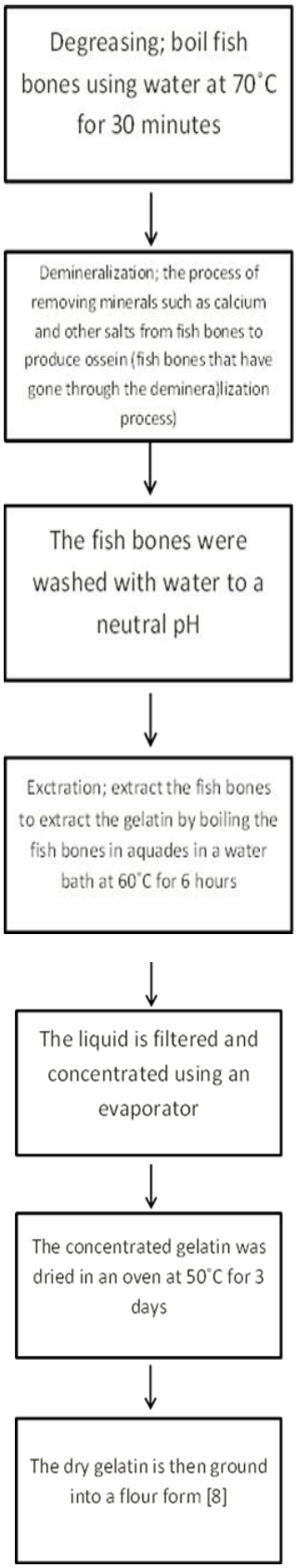

Fig. 2. Flowchart of extracting gelatin from fish bones

4. UTILIZATION OF FISHBONES FOR HYDROXYAPATITE PRODUCTIONS

According to Anggresani et al (2019), hydroxyapatite is a type of apatite material that has the chemical formula $Ca10(PO4)6OH_2$. Hydroxyapatite is included in bioceramics which has recently been intensively studied related to its application in the medical field [13].

Hydroxyapatite is a component of hard tissue in the bones, teeth, and dentin of the human body. Therefore, it is widely used as the primary material for making implants. Its resemblance to human bones has been shown to be biocompatible with human bones and teeth [14].

Hydroxyapatite is also used as a bone regeneration material and in the orthopedic field. The application of hydroxyapatite is based on the properties of hydroxyapatite, which are bioresorbable, osteoconductive, bioactive, biocompatible, non-toxic, and environmentally friendly [15]. The biocompatible nature of hydroxyapatite will make it acceptable to body tissues and make hydroxyapatite as one of the precursors for the manufacture of biomaterials that are able to treat or replace organ tissue or function of the body and are used as supporting material for enzyme immobilization [16].

The stages of processing fish bones into hydroxyapatite are carried out by boiling fish bones in water at a temperature of 80˚C for approximately 30 minutes. After that wash the fish bones with water to remove the remnants of the meat that is still attached. Then soak the fish bones in the acetone solution for 3 days, the acetone solution should be changed every day. After soaking, dry the fish bones in the sun. Then, the fish bones were calcined using a furnace at 900˚C for 3 hours. The next step is to grind and sieve the fish bones with a 100 mesh sieve. After obtaining bone ash, the next step is the manufacture of hydroxyapatite. The method used is Sol Gel. Dissolve the powdered bone ash (CaO) in 96% ethanol, and add the 80% H3PO4 solution that was put into the biuret. The addition of H3PO4 is done slowly, drop by drop. Heat the mixture at 37˚C and stir with a magnetic stirrer at 300 rpm for 15 minutes. Then reheat in the bath for 1 hour at a temperature of 60˚C. Then leave it for about 1 day. After that add NH4OH to pH 10. Next, stir using a magnetic stirrer until it becomes a gel. The gel was baked in an oven at 105˚C for 12 hours. Then, the results of the oven are heated at 900˚C for 3 hours.

5. UTILIZATION OF FISH BONES AS GLUE BASE MATERIAL

Glue or adhesive is a material to glue two surfaces of solid objects. Generally, this glue is liquid and sticky. According to Wahyuningsih et al. (1991), fish bones can be used as glue because they contain collagen. Collagen adhesion is very high compared to carbohydrates contained in tapioca flour.

According to Nugroho et al (2015), the price of fish glue is quite expensive because it is liquid at room temperature and easy to use. However, the use of fish glue can reduce chemical waste from synthetic glue made from chemicals such as Polyvinyl Acetate (PVAc), Polystyrene, and Urea Formaldehyde.

The manufacture of glue from fish bones is carried out in three stages, namely preparation, extraction, and concentration. The preparatory stage is preparing the fish bones to be processed. Clean the fish bones from any existing dirt such as fish meat that is still attached or other impurities. Then in the extraction stage, the fish bones were boiled in 5% acetic acid solution in a water bath at a temperature of 65-70 °C for 4 hours. The ratio between fish bones and acetic acid solution is 1:1 (weight/volume). Then at the stage of concentration the extracted liquid is filtered to be separated from solid materials. Furthermore, the filtered liquid is concentrated using a rotary evaporator vacuum at a temperature of 65°C for 35 minutes [17].

The quality of the glue from fish bone material is strongly influenced by the origin of the type of fish. The results of Aji et al's research (2018) informing the quality of glue obtained from fish bones from different fish species are listed in Table 1.

Based on Table 1, fish glue made from red snapper (Lutjanus sp.) bone is the best product. The results of other research were also informed by Sulistyanto et al (2015), that the quality produced is influenced by the bone of origin of the fish species [18] (Table 2).

Table 1. Data on the difference in the quality of fish glue from three different types of fish bones

Fish Bone Raw Material	Fish glue quality				
	Stickiness (n/mm^2)	Wood damage (%)	Viscosity (poise)	Water content (%)	Acidity (ph)
Stingray	11,86 ± 0,85b	57,78 ± 2,77b	3,94 ± 0,26b	49,03 ± 0,19a	5,65 ± 0,003c
Red Snapper	13,45 ± 0,45c	72,29 ± 4,04c	3,87 ± 0,26a	54,71 ± 0,31b	5,08 ± 0,003a
Catfish	4,10 ± 0,47a	6,12 ± 1,50a	4,02 ± 0	65,51 ± 0,17c	5,41 ± 0,001b

Description:

- *Data is the average of three repetitions + Standard Deviation*
- *Data followed by different superscript letters in the same column, shows that there is a significant difference (P < 0,05)*

Table 2. Data on differences in fish glue quality from three different types of fish bone

Fish Bone Raw Material	Fish glue quality				
	Stickiness (n/mm^2)	Wood damage (%)	Viscosity (poise)	Water content (%)	Acidity (ph)
Mackerel	6,8 ± 0,78a	72,23 ± 1,04a	4,53 ± 0,066a	4,33 ± 0,060a	48,77 ± 0,68a
Tuna Fish	7,7 ± 0,87b	83,21 ± 1,78b	4,17 ± 0,050b	4,74 ± 0,051b	55,60 ± 0,58b
Cobia	5,3 ± 0,94c	62,07 ± 1,92c	4,33 ± 0,046c	4,47 ± 0,060c	50,60 ± 0,22c

Description:

- *Data is the average of three repetitions + Standard Deviation*
- *Data followed by different superscript letters in the same column, shows that there is a significant difference (P < 0,05)*

Based on Table 2, fish glue made from tuna fish bones is the best product

6. UTILIZATION OF FISH BONES FOR ACCESSORIES

Fish bones are fishery waste that are easily found in coastal areas, fish markets, and seafood restaurants. So far, fish bones are commonly used as animal feed ingredients. Fish bones are ground into bone meal. Most people throw this fish bone waste because it is no longer useful. During the fish harvest period, people no longer have time to process fish bone waste. Fish bone waste is so distracting because it is thrown away around the environment.

Fish bone waste can actually be used as a basic material for crafts, which is quite unique and artistic. Accessories craft products from fish bones are still relatively rare, so they have the potential to be developed further. People who live near ocean waters, beaches or fish markets will have no trouble getting fish bone waste and don't need to spend a lot of money to get the raw materials for this craft.

The utilization of fish bone waste into accessories craft products has more value in the economic field. Now people have started to like handicraft products made from fish bones, because they are unique, artistic, interesting, and also environmentally friendly. So it can be said that the business opportunity from fish bone waste can be profitable.

Each part of the fish bone has its own uniqueness. All of them can be used as basic materials for crafts. The parts that can be used are the skull, fins, middle of the tailbone, tailbone, and many more.

Processing of fish bones is done in a simple way. After being washed, the fish bones are dried in direct sunlight. One thing that needs to be considered is separating the parts that have the potential to be used as appropriate craft products. Fishbones can also be colored using a spray dye.

Making accessories from fishbone waste needs to be studied further so that the resulting product will develop. Technological advances will also assist in the treatment of residual waste which can lead to higher selling prices. Therefore, in making accessories, we must know good and quality materials, and what technology should be used. Thus, the higher the product quality and the higher the selling price.

Utilization of fish bone waste as an accessory is useful for reprocessing the waste that is not used and becomes economically valuable. In addition, it can also be a side income in the sale of products produced from waste. In making accessories from fish bone waste, high skills and creativity are needed in order to produce good products, quality products and have high selling points.

For the market segment, we can easily find accessories for fish bone products in offline stores or online stores. With easy access like now, we can buy or sell the results from the utilization of fish bone waste that is used as accessories. So, sellers will easily determine the market and buyers can find them easily.

7. UTILIZATION OF FISH BONES FOR LOTION

Collagen is a long and fibrous structural protein that contains three peptide chains, which form a triple helical structure by intra-molecular hydrogen bonds between Gly and Hyp in adjacent chains [19].

There are many types of collagen that make up tissues, including type I collagen found mainly in skin, bones and tendons, type II collagen found in arterial cartilage in joints, and type III collagen which is the main element of blood vessels [20]. Collagen is the most abundant protein in animal tissues with a proportion of 30% of total body protein as the main component of connective tissue, muscle, gums and skin [21].

Fish bones are believed to be able to be one of the compositions in making lotions by taking the collagen. In a study conducted by Hepni (2013), it was made by extracting catfish bones first to obtain catfish bone collagen powder which was then characterized using chemical composition analysis, namely water content analysis, ash content analysis, protein content analysis and fat content analysis. Catfish bone collagen powder was weighed according to each concentration. Add half the lotion base to the mortar, add the catfish bone collagen powder according to the respective concentrations and grind it homogeneously [22].

The results of the study also stated that the lotion with the addition of collagen composition from fish bones was able to moisturize the skin up to 54.3% than before using the lotion. Catfish bones contain collagen which was tested using the Fourier Transform Infared (FTIR) instrument with wavelengths of 3250-3350 cm-1 and 1260-1630 cm-1 which indicated the presence of amine and amide groups. Catfish bone collagen can be formulated into lotion preparations with an oil-in-water (W/W) emulsion type, all preparations are homogeneous and stable preparations and do not irritate the skin, with a pH range of 6.3 when finished, and a pH range of 6.0 -6.3 after storage for 12 weeks.

8. CONCLUSION

Based on the results of a review of published articles, fish bones can be used for non-food products. These non-food products are organic fertilizers, gelatin to be applied to non-food products, hydroxyapatite, glues or adhesives, accessories and lotions or skin moisturizers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Indonesian Ministry of Industry. Commodity data for fish processing factories throughout Indonesia. Accessed September 16, 2022 Available:https://bit.ly/2VqCGRF.
2. Trilaksani W, Salamah E, Nabil M. Utilization of tuna bone waste (Thunnus sp.) as a source of calcium by protein hydrolysis method. Journal of Indonesian Fishery Products Processing. Indonesia. 2006;9(2).
3. Beatricx LMT, Fadilla HU. Effect of pH and stirring speed on protein extraction from chicken bones with NaOH solvent solution. Technical Report. Diponegoro University. Indonesian; 2011.
4. Nurilmala M, Wahyuni M, Wiratmaja H. Improving the value added waste of tuna fish bone (Thunnus Sp.) into gelatin and physical-chemical analysis. Journal of Indonesian Fishery Products Processing. Indonesia. 2006;9(2):22–33.
5. Aji GI, Darmanto YS, Kurniasih RA. Comparison of the quality of fish glue from three different types of fish bone. Scientific Journal of Technoscience. Indonesia. 2018;4(1):56-61.
6. Santoso C, Surti T, Sumardianto. Differences in the use of citric acid solution concentration in making gelatin cartilage of

mondol stingray (Himantura gerrardi). Journal of Processing and Biotechnology of Fishery Products. 2015;4(2):106–114. Indonesia.
Available:http://www.ejournal-s1.undip.ac.id/index.php/jpbhp

7. Naiu AS, Yusuf N. Sensory value and viscosity of skin cream using tuna bone gelatin as emulsifier and humectant. Journal of Indonesian Fishery Products Processing. Indonesia. 2018;21(2): 199.
Available:https://doi.org/10.17844/jphpi.v21i2.22838
8. Junianto J, Haetami K, Maulina I. Characteristics of capsule shells made from fish bone gelatin. Indonesian Journal of AquaticsIndonesia. . 2013;4(1).
9. Rosida R, Handayani L, Apriliani D. Utilization of goat-goat fish bone waste (*Abalistes stellaris*) as gelatin using various concentrations of CH3COOH. Acta Aquatica. Indonesia. 2018;5(2):93–99.
10. Yusa AT, Najib Atmaja. Analysis of stingray skin gelatin film tensile strength. Proceedings of the 2010/2011 Even Semester Final Project, Chemistry-FMIPA ITS Proceedings; 2011.
11. Pranoto Y, Marseno DW, Rachmawati. Characteristic of Gelatin extracted from fresh and sun-dried seawater fish skins In Indonesia. International Food Research Journal. 2011;18(4):1335-1341.
12. Anggresani L, Nursing S, Rahayu IJ. Mackerel fish bone waste (*Scomberomorus guttatus*) as a source of calcium in making hydroxyapatite. Catalyst Journal. Indonesia. 2019;4(2):133-140.
13. Akbar AF, Qurrota F, Aini, Nugroho B, Cahyaningrum SE. Synthesis and characterization of baung fish bone hydrosapatite. Journal of Research Chemistry. Indonesia. 2021;6(2):93-101.
14. Amin A, Ulfah M. Synthesis and characterization of hydroxyapatite composite from lamuru fish bone (*Sardilnella longiceps*) - Chitosan as Bone Filler. Journal of Pharmacy FIK Uinam. Indonesia. 2017;5(1):9-15.
15. Nurmanta DA, Masruroh, Santjojo DD. Improvement of compressive strength value of hydroxyapatite scaffold bioceramic using DHF plasma treatment. Journal of Qua Teknika. Indonesia. 2021;11(1):1-9.
16. Saleha, et al. Synthesis and characterization of hydroxyapatite from eggshell calcium oxide (CaO) nanoparticles for dental implant applications. Yogyakarta: Proceedings of the XXIXHFI Central Java & DIY Scientific Meeting; 2015.
17. Nugroho IT, Darmanto YS, Amalia U. The comparison of the quality of glue which is made by fish bones from three different species of marine fish. Fisheries Science : Indonesian Journal of Fisheries Science and Technology. Indonesia. 2015;11(1): 72-77.
18. Sulistyanto EP, Darmanto YS, Amalia U. Characteristics of fish glue from three different types of marine fish. Journal of Tropical Marine Science and Technology. Indonesia. 2015;7(1):23-31.
19. Hua-Jie W, Ling D, Qiu-Shi D, Jin-Ye W. Applications and degradation of proteins used as tissue engineering materials. Journal Shanghai: Biomedical Engineering, School of Life Science and Biotechnology, Shanghai Jiao Tong University. China; 2009.
20. Cahyanto A. Biomaterials. Bandung: Padjadjaran University. Indonesia. 2009; 65.
21. Kittiphattanabawon P, Benjakul S, Visessanguan W, Nagai T, Tanaka M. Characterization of acid-soluble collagen from skin and bone of bigeye snapper (*Priacanthus tayenus*). Journal of Food Chemistry. Thailand; 2005.
22. Hepni. The formulation of the lotion preparation uses catfish bone collagen (Pangasius sp) as a skin moisturizer. Indonesian Trust Health Journal; 2021.

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