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REVIEW ARTICLE; UTILIZATION OF FISH SCALES FOR FOOD PRODUCTS

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Abstract

This review article aims to inform the use of fish scales into food products or as intermediate products used for food products. Based on the literature study, information was obtained that fish scales can be used as food products directly or indirectly. The direct use of fish scales into food products is made of snack chips. Indirect use as food products, namely 1) Fish scales are extracted into gelatin and the gelatin is used as raw material for jelly candy. 2) Fish scales are extracted into chitosan and the chitosan is used as a preservative for food products such as fish balls, fish sausages and others.

Keywords: chips, chitosan, gelatin, jelly candy, preservative.

Introduction

Fish scales are a *waste product* of a fish processing industry and households. So far, in Indonesia, fish scales have not been used optimally. Fish scale waste that accumulates and is not utilized will clearly cause environmental pollution. According to Aziz et al (2017) untreated fish scale waste can cause unpleasant odors and can cause diseases such as diarrhea.

Scales are the integumentary system that covers the body. This system has a function as a protector between the body of living things and their environment. The shape, size, and number of scales on the fish can describe the life of the fish. Fish scales have various shapes and sizes. There are 5 types and types of scales namely placoid, cosmoid, ganoid, cycloid, and ctenoid. Ganoid scales are large and rough scales, cycloid and ctenoid scales are small, thin or light scales to placoid scales are soft scales (Iqbal 2014 in Fitriana 2021).

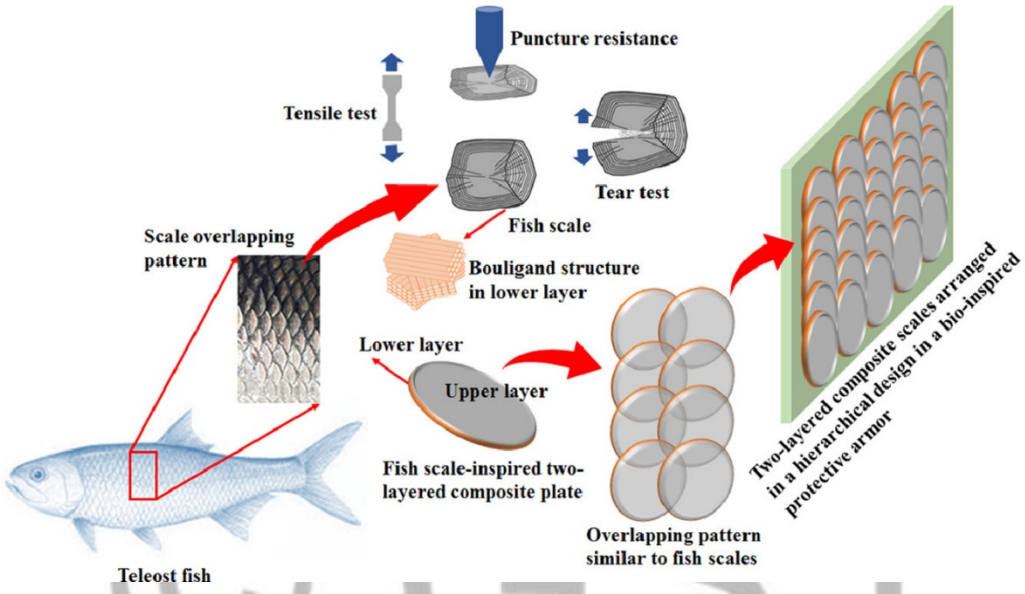

Figure 1. Fish scales (Source: Rawat et al., 2020)

Fish scales contain organic compounds, among others 41-84% are protein and the rest are mineral residues and inorganic salts such as magnesium carbonate and calcium carbonate. The content of fish scales in general is 70% water, 27% protein, 1% lipid and 2% ash. The protein contained in fish scales is mostly collagen (Loppies et al 2020). According to Ramdhani and Firdausi (2021), fish scales contain chitin which can be converted into chitosan.

Based on the organic compounds found in fish scales, there are alternatives to utilize or process these fish scales into value-added food products. This review article aims to inform the use of fish scales into food products or as intermediate products used for food products.

Processing of Fish Scales into Chips Snack

Chips are processed snacks that can be made from vegetable or animal ingredients and are usually packaged in a package to keep the quality crispy. Chips, as a smaller portion of food than a regular meal, are generally eaten between meals. Chips as small amounts of food eaten between meals, or very small meals.

Figure 2. Fish scale chips (Source: Mulyani and Farida, 2012)

Changes in time and current eating habits have resulted in substantial changes in both the frequency and type of food consumed. These substantial changes create opportunities to produce new snacks with different sensory, nutritional and technological characteristics.

The main raw material sources for chips generally come from vegetable ingredients, namely tubers, vegetables and fruits. However, one of the problems faced in the processing of chips sourced from vegetable materials is the nature of these materials which are susceptible to browning reactions due to enzyme activity. The browning process will reduce quality and reduce consumer interest.

Several studies have tried to inhibit the occurrence of enzymatic browning reactions such as chemical, physical (blanching, freezing), controlled atmosphere, and coating methods. However, this method is complicated and takes a lot of time to do (Arum et al., 2022).

One source of alternative raw materials in the manufacture of chips is fish scale waste. Besides being an alternative and innovative raw material, fish scale waste also contains a lot of nutrients in it. The fish scales selected must be of good quality because some fish contain high levels of mercury and other toxins and contaminants that can reduce quality and cause disease (Darmono, 1995).

The process of making fish scale chips is as follows (Mulyani and Farida, 2012): a) Fish scales are washed with running water until clean so that the dirt attached to the fish scales will disappear. To get rid of the fishy smell, the washed fish scales will be soaked in lime juice for half an hour then rinsed again and drained. b) Next, mix various spices with fish scales, such as shallots, garlic, ginger, turmeric, coriander, and pepper for 3 hours to allow the flavors to infuse. c) After the spices have been absorbed, the seasoned fish scales are steamed for 1 hour and drained again. d) Then do the addition of cornstarch, flour, and eggs into the fish scales and wait again for 1 hour. e) Fish scales that have been processed are put into a frying pan containing hot oil and fried until golden brown.

Extraction of Gelatin from Fish Scales for Ingredients for Jelly Candy Products Jelly

Candy or soft confectionery is a type of snack in solid form, made from sugar or a mixture of sugar with sweeteners. According to the Indonesian National Standard (2008), jelly candy is a soft textured candy that is processed with the addition of hydrocolloid components such as agar, gum, pectin, starch, carrageenan, gelatin and others which are used for texture modification.

One of the ingredients used in making jelly candy is gelatin. This gelatin can be obtained from fish scales. Until now, the main source of gelatin is beef and pork, namely the skin and bones. The use of these two sources of gelatin in the food industry is constrained by religious factors and food safety.

Gelatin is a protein compound extracted from animals, which can be obtained from partial hydrolysis of collagen, heat denaturation of collagen breakdown in animal collagen tissue (Hastuti and Sumpe, 2007). Gelatin is a soluble protein with properties as a gelling *agent* as a *non-gelling agent*. Sources of gelatin raw materials can come from cattle, pork, and fish. Gelatin is a pure protein food that is easy to digest, but is nutritionally incomplete due to a deficiency of certain amino acids. The characteristics of gelatin are, almost tasteless, odorless, and generally yellow in color. Gelatin is also available as a fine blend with added sugar, flavoring, acid, and coloring.

Gelatin from fish scales is preferred because it produces large amounts of gelatin due to its high amino acid (proline) content compared to fish skin (Zakaria et al., 2015). The procedure

for extracting gelatin from fish scales is as follows (Jakhar et al., 2012): 1) Fish scales are cleaned thoroughly and rinsed with water to remove harmful materials 2) After that, fish scales are immersed in NaOH solution at a concentration of 0.23 M for 47 Minutes. 3) Then, it was soaked in 0.2% sulfuric acid for 40 minutes. 4) After that, it was immersed in 0.7% citric acid solution for 40 minutes. 5) Next, the fish scales were washed with running water until it had a pH of about 7.0. 6) The next stage is the extraction process with water (aquadest) at a temperature of 55^{o}C for 17 hours. The ratio of scales to: water used is 1:3 (w/v). 7) The clear extract obtained was filtered through Whatman filter paper (No. 1), using a Buchner funnel. 8) The filtrate is then stored in a tray and dried in an oven at 60 °C for 16 hours. 9) Thin film of dry matter is gelatin powder that is ready to be used for making jelly candy.

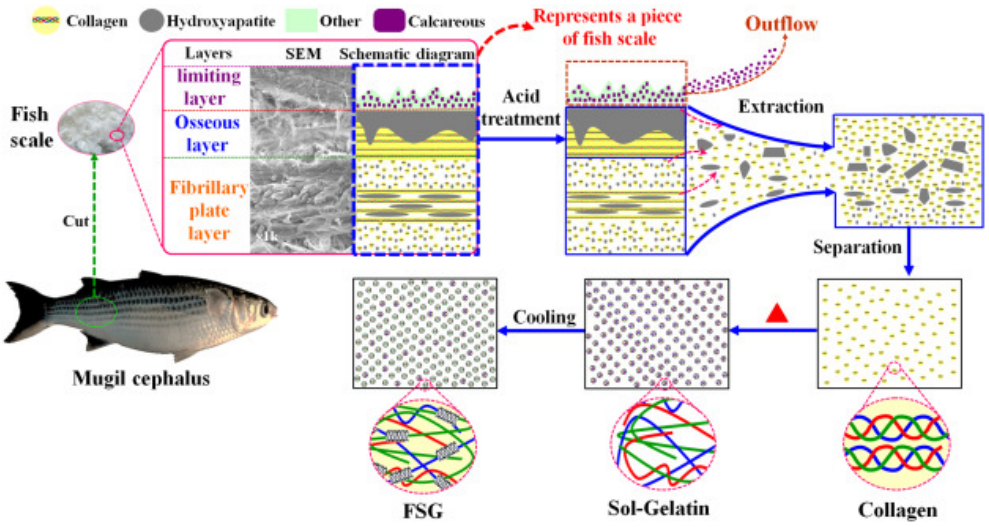

Figure 3. Schematic diagram of collagen extraction scales and fish scale gelatine (FSG) formation. (Source: Wu et al., 2020)

Candy begins with dissolving sucrose and fructose in hot water, then gelatin extracted from scales and carrageenan is added and stirred, then sodium benzoate, flavor and acid are added. citric. The dough is then poured into a square mold and allowed to stand until it reaches room temperature. Then the product is put in the refrigerator. After that, the product is removed from the mold and then cut into squares. Be jelly candy.

Chitosan Extraction from Fish Scales for Edible Coating Fish Meatballs

Chitin is a polymer of a polysaccharide group found in fish scales. The chitin content in fish scales varies greatly depending on the type of fish. Chitin can be acetylated into chitosan.

The stages of extracting chitosan from fish scales can be carried out through 5 stages, namely (Susanti and Purwanti, 2020): Material preparation, Deproteinization Stage, Demineralization Stage, and Deacetylation Stage.

Figure 4. Processes for preparation of chitin from fish scales (Source: Kumar al., 2021)

The preparation stage is carried out as follows: Fish scales are washed thoroughly and then dried for 1 day. Fish scales that have been dried, blended until smooth.

The deproteinization step was carried out as follows: The fish scale powder was weighed and put into a glass beaker and 3.5% NaOH solution was added with a ratio of solid: solvent = 1:10. Then heated and stirred using a magnetic stirrer constantly for 2 hours at a temperature of 65°C (deproteinization stage), then filtered. The precipitate was then neutralized with distilled water until the pH was neutral and then dried.

The demineralization step was carried out as follows: The dried precipitate was then put into a glass beaker and then 1 N HCl solution was added with a ratio of solid: solvent = 1: 15 for 30 minutes at room temperature. The precipitate was then filtered, neutralized with distilled water until the pH was neutral and then dried. The product of this process is called chitin.

The last stage is the deacetylation stage, the dried chitin is then put into a glass beaker and added 50% NaOH solution and heated at 90^{o}C for 1 hour with a ratio of solid: solvent = 1: 10. After that it is filtered until the pH is neutral, and dried (chitosan).

Chitosan has the potential to be used as a food preservative, because chitosan has a positive charge so that it can inhibit microbial growth and is able to bind to negatively charged compounds such as proteins, polysaccharides, nucleic acids, heavy metals and others. In addition, the chitosan molecule has an N group which is able to form amino compounds which are components of protein formation and has an H atom in the amine group which makes it easier for chitosan to interact with water through hydrogen bonds. (Rochima, 2007).

One of the processed fish products that can be preserved with chitosan is fish balls. Meatballs are a food product that is favored by many people because of the relatively cheap price, made from fish meat, or beef which is mashed and added with sago flour. The meatballs are shaped round either manually or by using a ball-making machine.

The application of chitosan as preservation of fish balls is by coating the fish balls, known as edible coating. The procedure was first to make a solution of chitosan. The preparation of a chitosan solution was carried out based on the method carried out by Wulandari (2015), namely as follows: Chitosan obtained from fish scales was dissolved in 1% acetic acid solution. The next stage is coating the fish balls by soaking the fish balls in a chitosan solution for 60 minutes at room temperature.

Erlina (2021) research results show that fish balls coated with chitosan are more durable than fish balls that are not coated. The benefit of chitosan in general is that it can increase the durability of various food products such as sausages, nuggets, fruit/vegetable juices, tofu, salted fish, wet noodles, processed fish products, fruits, and lunkhead.

Conclusion

Based on the literature study, information was obtained that fish scales can be used as food products directly or indirectly. The direct use of fish scales into food products is made of snack chips. Indirect use as food products, namely 1) Fish scales are extracted into gelatin and the gelatin is used as raw material for jelly candy. 2) Fish scales are extracted into chitosan and the chitosan is used as a preservative for food products such as fish balls, fish sausages and others.

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