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Extraction of Gelatin from Salmon Bone

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Abstract: Gelatin is a hydrocolloid that works as a gelling agent, thickener and stabilizer. Since gelatin is among the most extensively used food ingredients, it is in high demand for culinary and pharmaceutical applications. Gelatin is often manufactured from bovine and porcine. Certain individuals are unable to consume gelatin that had bovine and porcine in ingredients due to religious beliefs. The use of fish waste as a source of gelatin is another good option. The objective of this study is to analysis the yield of extracted gelatin and proximate composition fish bone. Besides, to study the effectiveness of demineralization and thermal extraction process. The results shows the pre-treatment that using acid more effective than alkaline due to perform prior extraction. The production of gelatin had 4 stages, preparation, pre-treatment, extraction and refining. Therefore, fish bone can be applied in food or non-food industries.

Keywords: Gelatin, Salmon Bone

1. Introduction

Gelatin is a protein of high molecular weight, a heterogeneous mixture of a water-soluble molecule (biopolymer) produced by thermal denaturation from collagen. As an ingredient, it was used in it increases the aqueous system's viscosity and forms an aqueous gel. Gelatin also used extensively in medical, it is commonly used as it dissolves and absorb easily inside of the human body. In the food and pharmaceutical industries, while most gelatins are used, some of them are still used in technological applications such as microencapsulation, paper sizing and adhesives. In each food industry, it has different functions, such as chewiness, creamy mouth texture, emulsification and waterbinding. In the manufacture of printer ink, film coating, x-ray film and colour tape, the photographic industry uses gelatin.

Gelatin is derives from breakdown of collagen, so collagen-containing tissues are typically used

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as a source of gelatin. The most widely used source of collagen for gelatin in mammals, birdsand fishes is derived from body protein constituents of the skin, tendons, cartilage, bone and connective tissues, while collagen is an integral component of the wall of the body in invertebrates.

Therefore, by commodity, the sources of abundance of fish, such as bones, scales and skin can be an excellent source of gelatin. In gelatin extraction, fish bones are favoured because they produce significant quantities of gelatin due to the high imino acid content (proline) compared to fish skin. The gel strength properties of the industrial pigskin and bones are almost similar. The present study aims to determine the best quality of gelatin and effective pre-treatment methods from fish boneusing Salmon.

Most of the advertisements today, gelatin is extracted from mammalian sources, mostly from pigskin and cowhide, but alternative sources are extremely popular for several sociocultural purposes. Over the years, the global demand for gelatin has shown a growing trend. Latest estimates suggest that the global world production of gelatin is almost 326,000 tons. The bulk of commercial gelatin canbe derived from porcine or bovine skin, scales, bones, ligaments and tendons. Porcine and bovine gelatin use is vitally restricted by religious considerations. Muslim, for example, are prohibited from consuming all products related to pork, and Hindus are prohibited from consuming all products related to cows.

In addition, bovine gelatin, commonly known as mad cow disease and foot-and-mouth disease (FMD), has a potential chance of transmitting bovine spongiform encephalopathy (BSE). Therefore, the study of gelatin from fish, such as bones is of interest because of these religious and health issues [1].

Processing fishery discards 70%-85% of the overall catch weight is accounted for, and 30% of fish waste is in the form of bones and skins. Fishery by-products are typically discarded worldwide as waste that causes severe environmental issues and economic losses. It is estimated that waste from fish is output varies from 17.9 to 39.5 million tons per year, which is a major loss of valuable nutrients.

2. Materials and Methods

2.1 Materials and reagent

Salmon fish is bought from farm Salmon at Norway. The bones were packed and stored immediately at -20°C before the gelatin extraction process. The manual scraping process, bones are washed thoroughly with insufficient water to remove leftover flesh and impurities. Bones used for gelatin extraction are washed and afterwards degreased by dropping into water bath at 35°C for 30 minutes. The cleaned fish bones are cut into small pieces which 1 to 2 cm with 100g per specimen.

2.2 Gelatin Extraction

At 20 – 25 °C of ambient temperature, the bones are demineralized using hydrochloric acid (HCl) to remove non – collagenous protein in 16 hours with ratio (1:6 w/v). The fish bones proceeded via consecutive cleaning with ample tap water as well as distilled water to achieve pH (4-7) which tested by using pH test. The bones soaked in distilled water in beaker with ratio 1:8 w/v (weight bone in g: volume distilled water in ml), gelatin will be extracted. After that, immersed the beaker inside the water bath at 60°C for 8 hours. The results produced are filtered using cheese cloth. Then, evaporated and dried at 60°C for 24 hours in oven before brittles sheets are developed. The gelatin sheets extracted are pulverised into gelatin powder and deposited until further research under desiccation.

2.3 Gelatin yield

Percentage yield of gelatin was determined by using formula below;

$$\%\ yield = \frac{(mass\ of\ dried\ gelatin)}{(mass\ of\ clean\ bones)} \times 100 \qquad \text{Eq. 1}$$

2.4 Gel strength

Dissolve dry gelatin powder with distilled water in 150ml beaker to get concentration gel of 6.67% w/v. then, stir the mixture at room temperature for 1 hour. The mixture soaked into the water bath at 65C for 30 minutes. After that, chilled in refrigerator at 4C for 18 hours. The gel strength was measured by using Texture analyser (Model TA.XT plus, Stable Micro System, Surrey, UK) with load cell 5kg, crosshead speed 0.5mm/s and equipment with flat face cylindrical plunger with diameter 12.7mm. The penetration distance is 4mm into gelatin gel. The maximum force (g) and gel strength was recorded.

2.5 Melting temperature

Gelatin solution of 6.67% (w/v) was prepared and 5 ml of solution were poured into test tube. The tubes covered with parafilm and heated at 60C for 15 minutes in water bath. After that, the samples was allowed to cool down into ice-chilled water and matured at 10C for 18 hours. Then, prepared the mixture of 75% chloroform and 25% dye (food color) and added 3 drops on the gelatin gel surface. The gel was placed in a water bath at 10C and heated at rate 0.2 to 0.4C/min. the melting temperature was recorded when dye drops began to move freely down in the tube.

2.6 Proximate composition

Proximate composition including moisture, protein, ash and lipid. The method according to AOAC official method [2]. The pH of raw material and extracted gelatin was measured by using pH meter. Gelatin from bone was cut and mixed for minutes in distilled water to make a solution of 1% (w/v) for fish bone. The total protein concentration in the gelatin solution was determined using Biuret method.

3. Results and Discussion.

3.1 Gelatin yield

The range mean yield of dry gelatin from fish is 6% to 19%. According to experiment [3], gelatin yield for salmon is 2.5±0.5% on wet basis which is using sodium hydroxide (NaOH) as a pre- treatment. Figure 1 shown the comparison of gelatin yield for salmon, shark, tuna, milkfish, mackereland blue whiting bone.

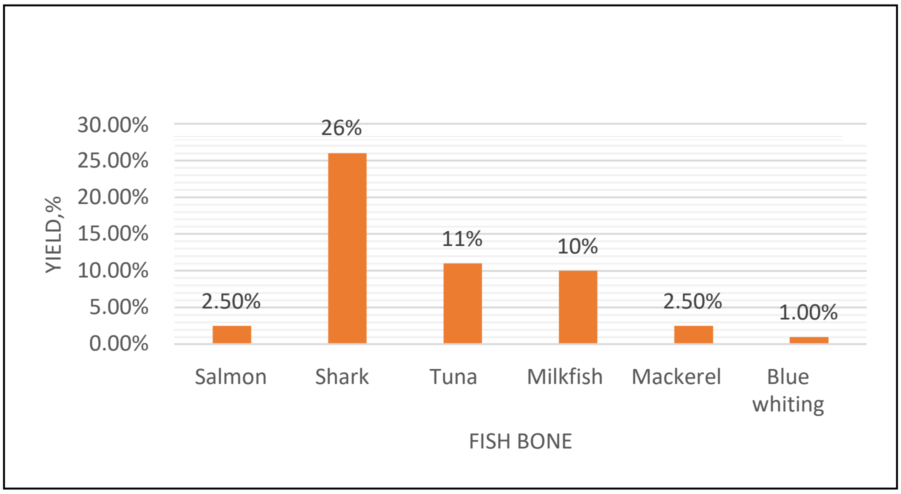

Figure 1: Comparison gelatin yield between salmon and other fish

Salmon bone has a lower gelatin yield (2.5%) compared to shark bone but higher than blue whiting bone (1.0%). Shark bone waste generated the most gelatin yield (26%). The variation in percent gelatin yield varies between fish species, based on collagen (protein content), skin or bone compositions, and pre-treatment which has also been reported in many papers due to changes in extraction procedures [1,4,5]. In the other research, gelatin yield values extracted from skins or bones of several other fish, including such black tilapia 5.4%, red tilapia 7.8% [1]; catfish 17.52% [6];Nile perch 2.40% [4] and channel catfish 8.43% [7].

3.2 Gel strength

The strength of gel, also known as bloom value, will be the focus of the distinctive evaluation of the gel. The gel strength of fish gelatin is often lower than that of mammalian gelatin. Along with a recent study, the fish gelatin gel strength ranges from 124 to 426g [8], whereas commercial gelatin, like bovine and porcine, ranges between 200 to 350g. This signifies that the gelatin acquired in this investigation falls within an acceptable limits. Gel strength of 108g for salmon gelatin lower than bovine gelatin, 350.5g. The gel strength of salmon gelatin was higher than gelatin such as bigeye snapper, 105.7g and cod, 90g [9]. The difference in gel strength values between these species could beattributed to the presence of proline and hydrxyproline amino acids.

3.3 Melting temperature

Fish bone gelatin has a lower melting temperature compared to mammalian gelatin like bovine and porcine. The melting temperature range for fish and mammalian from 11 to 28°C and from 28 to 38°C, respectively. From previous researchers [10], melting temperature for sardinella fimbriata boneis 25±1.52°C which is low than bovine gelatin, 38±1.53°C. That statement also supported by other researchers with different species of fish such as pangasius catfish (28±1.0°C) [11], pangasinodon hypopthlamus (26.17±0.44°C), protonibia dicanthus (26.92±0.44°C), red snapper (26±0.07°C) and grouper (25±0.03°C) [12].

3.4 Proximate composition

Based on the Table 1 below that sardinella fimbriata gelatin contained higher moisture (14.3±0.21%) than commercial gelatin (5.91±0.72%) which is the lowest moisture. In this study, commercial gelatin was found that contain higher amount of protein. The extraction gelatin from sardinella fimbriata and pangas catfish had contained 59.1±0.29% and 73.44±2.58%, respectively. The lowest protein iscatfish (clarias gariepinus) which 30.77±0.88%. A high ash content was obtained from catfish (clarias gariepinus) bone gelatin which has 12.62±0.73% while commercial gelatin has 1.45±0.27% which contained the lowest ash. The results obtained for lipid content for all sample shows that commercial gelatin (0.43±0.14%) has a much lower lipid content compared to pangas catfish bone gelatin (0.69±0.13%) but catfish (clarias gariepinus) was higher lipid content than other samples. The different of proximate composition results for all samples may be influenced by the extractionprocess.

Table 1 The chemical compositions of fish bone gelatin

Analysis	Moisture	Protein	Ash	Lipid	References
Catfish (Clarias gariepinus)	11.43±1.14	30.77±0.88	12.62±0.73	0.95±0.4	[6]
Sardinella fimbriata	14.3±0.21	59.1±0.29	4.7±0.21	0.76±0.44	[10]
Pangas catfish (pangasius pangasius)	8.27±1.63	73.44±2.58	3.18±0.25	0.69±0.13	[11]
Commercial gelatin	5.91±0.72	92.38±3.89	1.45±0.27	0.43±0.14	[11]

4. Conclusion

The chemical qualities of gelatin are linked to its functional characteristics. The molecular weight distribution and amino acid makeup of gelatin determine its yield, gel strength, and melting point. From this review, salmon had 2.5% of gelatin yield and 108g of gel strength. The salmon gelatin hada slightly greater amount of amino acids, which is most likely why the gel strength was higher. Salmon gelatin has a lower serine level than beef gelatin, which was the most significant chemical difference. Based on a survey of numerous papers and other materials, it can be determined that manufacturing gelatin acidic ally is significantly more reliable for fish bones, as acid solutions hydrolyse considerably greater collagen than alkaline solutions.

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