Characterization chemical composition of skin and head bones barracuda (*Sphyraena jello*) as collagen raw material

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Abstract. Barracuda is one type of fish that is widely used in the diversification of processing fishery products. This business will increase the amount of waste if it is not managed optimally. This study aims to utilize fish skin and head bones as raw material for collagen, which can reduce the amount of fish processing waste and provide added value to the waste. Barracuda skin and head bones that will be used as a raw material in the manufacture of collagen are first characterized by analysis of the chemical composition of the skin, which includes water, ash, protein, fat content. This chemical composition analysis aims to assess the initial feasibility of barracuda skin and head bones as raw material for collagen. The results of proximate analysis of the skin and head bones of barracuda (*Sphyraena jello*) showed a water content of 67.39%; 22.56%, ash content 2.53%; 58.45%, protein content 21.69%; 14.32%, and fat content of 8.38%; 4.58%. Barracuda skin and head bones are still fresh in terms of the value of water content that is still in the range of water content of the skin and head bones in general. High protein levels in the skin compared to head bones barracuda allows it to be used as raw material for collagen. Barracuda skin and bone fat levels are high enough, so pretreatment needs to do to remove fat and minerals so that it can improve the quality of collagen produced.

1. Introduction

Collagen is a major structural component of white connective tissue, which covers almost 30% of the total protein in vertebrate and invertebrate tissue and organs. Mammalian collagen is found in the skin, tendons, cartilage, and connective tissue. The basic molecule that forms collagen is called *tropokolagen*, in which there are three polypeptide chains of the same length, together forming a helical chain structure. According to Chai et al. [1], collagen plays an important role in the food, cosmetics, biomedical, and pharmaceutical industries.

Sources of raw material for collagen production that are widely circulating in the market are skin and bones of pigs and cows. The problem is that the issue of mad cow disease or *Bovine Spongiform Encephalopathy* (BSE) causes concern about the use of collagen from a cow. Pig collagen is limited in its use, and there is a prohibition for Muslims to use all kinds of ingredients derived from pigs. Alternative raw collagen ingredients are fish skin and bones. According to Nalinanon et al. [2], fish skin and bones are potential raw materials for use as collagen sources.

One of the fish skin and bone material that has the potential to be used as a source of collagen is barracuda skin and head bones. The production volume of barracuda in Indonesia experienced an increase in 2014-2018 in a row was 13,045.00; 17,388.74; 26,400.00; 22,582.21; and 28,932.38 tons / year with an average increase of 121.79% per year (KKP, 2019). Barracuda production in South
Sulawesi also increased from 2014-2018 in a row which was 853.00; 1,804.10; 3,095.00; 2,215.04; and 3,315.35 tons / year with an average increase of 288.67% [3].

Barracuda is used in the form of fresh, frozen, dried salted, and fillets. Utilization of barracuda is currently mostly in the form of fillets used by home industry entrepreneurs as raw materials for processed meatballs, nuggets, dumplings, brains, pempek, and other processed. The development of the fish fillet processing industry has a positive impact that is as a source of foreign exchange and employment providers. However, this fillet industry also has a negative impact that is the waste produced in the form of heads, bones, stomach contents, scales, and skin.

Fish skin and bones are one of the waste processing of diversified products that have not been utilized and are only thrown away. Barracuda skin and head bones are very potential to be used as raw material for collagen. The utilization of barracuda skin and head bone waste as collagen sources can provide added value for the commercialization of fishery products and reduce waste that pollutes the environment and alternatives to halal collagen. The proportion of fish skin and head bone of a barracuda is 0.025% and 0.01% of the total weight of the fish. The amount of skin and head bone of the fish produced by fillets is quite low, but both have the potential to be developed into collagen.

The skin and fish bones of barracuda as raw material for collagen is first investigated for its chemical composition to see its feasibility as raw material for collagen. The raw material that can be used as a source of collagen production has a high protein content with the condition of fresh fish.

2. Materials And Methods

2.1. Materials and Tools

Materials used in this study were the skin and head bones of barracuda (Sphyraena jello). Fresh barracuda obtained from Maccini Baji Fish Auction Place, Pundata Baji Village, Labakkang District, Pangkep Regency. Chemicals for the analysis of fish skin characterization, i.e.: H$_2$SO$_4$, H$_3$BO$_3$, NaOH 30%, HCl 0.02 N, chloroform, methanol, equates, isopropanol, Na$_2$SO$_4$, vegetable oils, NaCl salt, sodium sulfate (equates) and other supporting chemicals.

The equipment used includes tools for the preparation process and tools for sample test analysis. Process tools include knives, forceps, and other supporting equipment for skin preparation, water bath, freezer, grinder, analytical scales, plastic packaging, and packaging bottles. Equipment for proximate analysis includes analytical balance, porcelain cup, oven, furnace, desiccator, pumpkin, Kjeldhal, distillation, electric bath, fume hood, burette, Erlenmeyer flask, and measuring flask.

2.2. Methods

Research methods consist of raw material preparation and analysis characterization of barracuda skin and bone material.

2.2.1. Barracuda Skin and Head Bones Preparation

Fresh barracudas are cleaned by removing the scales, head, fins, and viser. The fish is filled in, and then the skin and head bones are separated. Barracuda skin and head bones are cleaned and separated from the rest of the meat, which is still attached to the skin and head bone by scraping. The barracuda skin and head bone samples are cut into pieces, packaged with sealed polyethylene plastic, and then stored in a freezer until the sample ready to used.

2.2.2. Characterization of the Chemical Composition of Barracuda Skin and Head Bones

The barracuda skin and head bones that will be used are characterized first by analyzing the chemical composition of the skin and head bone [4], which includes water, protein, fat, and ash content.

2.2.3. Research Design and Data Analysis

Research design is an experimental study and conducted in a laboratory. Analysis of the chemical composition of the skin and bones was analyzed with three replications. Water, protein, fat, and ash content were analyzed descriptively, both quantitatively and qualitatively.
3. Results and Discussion

3.1. Preparation and Characterization Barracuda Skin and Head Bone

The barracuda was obtained at Maccini Baji Fish Auction Place (TPI), Pundata Baji Village, Labakkang District, Pangkep Regency. The weight of each barracuda is 200-300gr. Barracuda skin and head bones are separated from the meat manually using a knife. The skin and bones of the head are cleaned from the remnants of meat that are still attached by scraping, then washed with running water until clean and then put in a plastic bag that is tightly closed and stored in the freezer before being processed to the next step. Storage of the skin and bones in the freezer to maintain quality and freshness. Figure 1 shows the type of barracuda.

![Barracuda](image)

Figure 1. Barracuda (*Sphyraena jello*)

Barracuda skin and head bones that will be used as raw material for collagen are characterized first by analyzing the chemical composition of the skin and head bones. Chemical composition is an indication of the quality of a material. The chemical composition of the skin and bones of barracuda need to be known to determine the quality skin and bones of the head. Analysis of chemical composition conducted in this study included water content, protein, fat, and ash. Analysis of chemical composition of the skin and bones of the head was carried out with the aim to assess the initial feasibility of the skin and head bones barracuda as raw material for making collagen. The chemical composition of barracuda skin and head bones showed in Table 1.

| Table 1. Chemical composition of skin and head bones barracuda (*Sphyraena jello*) |
|------------------------------------------|
| **Chemical Composition of the Skin** | **Chemical Composition of the Head Bone** |
| Parameters | Percentage | Value (% bb) | Parameters | Percentage | Value (% bb) |
| Water | % | 67.39 | Water | % | 22.56 |
| Protein | % | 21.69 | Protein | % | 14.32 |
| Fat | % | 8.38 | Fat | % | 4.58 |
| Ash | % | 2.53 | Ash | % | 58.45 |

3.2. Water content

Water content in the skin and head bones barracuda was 67.39% and 22.56%. The value of the water content is still in the range of water content of fish skin in general so that it can be said barracuda skin is still in fresh condition. According to Fernández-Dráez et al. [5], the relationship between the level of freshness of the skin with physical characteristics and molecular components of gelatin, Gelatin obtained from fresh flounder (*Platichthys flesus*) fish skin contains more $\gamma$ (high molecular weight) components
than α and β components. This gelatin also contains gel strength higher compared to gelatin produced from the skin that has undergone frozen storage. Water content in the skin is higher than bone due to the biochemical activity of each tissue with different water requirements and different functions of the two tissues.

3.3. Protein Content
Barracuda skin protein content (21.69%) is higher than that of yellowtail fish skin protein (17.87%) [6]; but lower than the protein of tilapia (30.6%) and rainbow trout (41.12%) [7–9]. The high protein content in barracuda skin makes this fish has the potential to be used as raw material for collagen. Kołodziejska et al. [10] state that about 80% of the total protein in fish skin is collagen. Alfaro et al. [11] state that the protein content in fish skin greatly determines the amount of collagen contained in the skin tissue, so that the skin has a big enough opportunity as a source of collagen.

Barracuda bone protein content is 14.32% higher than milkfish bone protein (12.77%) [12] and leather jacket fishbone protein (Odonus niger) [13] which is 11.86%, but slightly lower than tuna head flour protein (15.05%) and cork fishbone protein (15.45%) [14]. Higher protein content in the skin than bones can be associated with a relatively high proportion of bone mineral compared to skin. The difference in protein content can be caused by differences in species, age, habitat, type of feed, and material preparation [8]. In an effort to utilize waste, it is possible for the head bone of a barracuda to be used as raw material for collagen.

3.4. Fat content
Barracuda skin fat content is quite high (8.38%) compared to the fat content in the skin of pacific cod (0.3%), Alaska pollock (0.4%), tilapia (1.1%) and stingray (Pastinachus solocirostris) (6.08%); but lower than the rainbow trout skin fat content (13.12%) [7–9,15] and Labeo rohita fish fat content which is 12% shows that barracuda skin contains less fat. Barracuda head bone fat content is 4.58% higher compared to cork fishbone fat content (3.59%) but lower than tilapia bone meal with a fat content of 5.82% [16].

These variations can be caused by differences such as age, season, and environmental conditions of the fish [17–19]. Biological processes in the body of a fish basically require nutrition, and one of which is fat. But the presence of fat in collagen will reduce the quality of collagen. According to Shon et al. [20], fat on fish skin will influence the characteristics and effectiveness of collagen produced. The fat contained in the skin and head bones of barracuda can be removed or reduced using EDTA (Ethylenediaminetetraacetat). The removal of fat is done by soaking the skin with 0.5 M EDTA for 24 hours (modification of Nagai and Suzuki [21]).

3.5. Ash content
Ash content on barracuda skin is quite high (2.53%) compared to the ash content of cork fish skin (0.34%), stingray (0.65%), alaska pollock (0.7%), pacific cod (2%), tilapia (2.1%), but lower than the ash content of rainbow trout (5.45%) [7–9,14,15,22]. Ash content in the head bone of Barracuda is about 58.45% is much higher than cork fishbone 44.11%, Pseudotolithus elongates (39.30%), Pseudotolithus typus (45.54%) and bone meal head of tuna fish (50, 45%) [23].

Ash content on barracuda skin and bones is affected by the availability of minerals in fish habitat. Ash content is a representation of the mineral content of the body that accumulates in the body of the fish. Muralidharan et al. [13] stated that the high ash content in the skin was related to the biochemical composition and thickness level of fish skin. According to Moeljanto [24], that most of the ash and minerals in fish meal come from fish bones. High levels of ash on the skin and bones of barracuda indicate the importance of optimizing the skin and bone pretreatment process to remove minerals in the skin and bones to improve the quality of collagen produced. Pretreatment to eliminate or reduce the amount of mineral skin and bone of barracuda is the same as that used in pretreatment to reduce or eliminate fat. Shon et al. [20], the presence of minerals will disrupt the effectiveness of collagen in its use in products, one of which is cosmetic products.
4. Conclusion

Based on the results of research that has been done, it can be concluded that:

1. Chemical characteristics of the skin and head bones barracuda involved proximate analysis. Proximate barracuda skin contains (water 67.39%; protein 21.69%; fat 8.38%; and ash 2.53%) and the head bones of barracuda contains (water 22.56%; protein 14.32%; fat 4.58%, and ash 58.45%).

2. Barracuda skin and head bones have a high protein content that allows it to be used as raw material for collagen.

3. It is necessary to pay attention to the pretreatment process because the fat content in the skin and mineral content in the head bones of barracuda are high enough, so it can be able to improve the quality of collagen produced.

Bibliography

[1] Chai H-J, Li J-H, Huang H-N, Li T-L, Chan Y-L., Shiau C-Y and Wu C-J 2010 Effects of sizes and conformations of fish-scale collagen peptides on facial skin qualities and transdermal penetration efficiency J. Biomed. Biotechnol. 2010

[2] Nalinanon S, Benjakul S, Visessanguan W and Kishimura H 2008 Improvement of gelatin extraction from bigeye snapper skin using pepsin-aided process in combination with protease inhibitor Food Hydrocoll. 22 615–22

[3] KKP Kementerian Kelautan dan Perikanan Kementerian Kelautan dan Perikanan 2019 Statistik Perikanan Tangkap Indonesia Tahun 2019 (Jakarta)

[4] AOAC 2005 Association of Official Analytical Chemists 2005. Official methods of analysis

[5] Fernandez-Diaz M D, Montero P and Gómez-Guillén M C 2003 Effect of freezing fish skins on molecular and rheological properties of extracted gelatin Food Hydrocoll. 17 281–6

[6] Astiana I and Nurjanah N T 2016 Karakteristik kolagen larut asam dari kulit ikan ekor kuning J. Pengolah. Has. Perikan. Indones. 19 79–93

[7] Bechtel P J 2003 Properties of different fish processing by-products from pollock, cod and salmon J. Food Process. Preserv. 27 101–16

[8] Songchotikunpan P, Tattiayakul J and Supaphol P 2008 Extraction and electrospinning of gelatin from fish skin Int. J. Biol. Macromol. 42 247–55

[9] Tabarestani H S, Maghsoudlou Y, Motamedzadegan A, Mahoonak A R and Rostamzad H 2012 Study on some properties of acid-soluble collagens isolated from fish skin and bones of rainbow trout (Onchorhynchus mykiss). Int. food Res. J. 19

[10] Kołodziejska I, Skierka E, Sadowska M, Kołodziejski W and Niecikowska C 2008 Effect of extracting time and temperature on yield of gelatin from different fish offal Food Chem. 107 700–6

[11] Alfaro A D T, Fonseca G G, Balbinot E, Machado A and Prentice C 2013 Physical and chemical properties of wami tilapia skin gelatin Food Sci. Technol. 33 592–5

[12] Fitri A, Anandito R B K and Siswanti S 2016 Penggunaan daging dan tulang ikan bandeng (Chanos chanos) pada stik ikan sebagai makanan ringan berkalsium dan berprotein tinggi J. Teknol. Has. Pertan. 9

[13] Muralidharan N, Shakila R J, Sukumar D and Jayasekaran G 2013 Skin, bone and muscle collagen extraction from the trash fish, leather jacket (Odonus niger) and their characterization J. Food Sci. Technol. 50 1106–13

[14] Rosmawati 2018 Potensi kolagen ikan gabus (Channa striata) sebagai gelatin alternatif dan aplikasinya dalam pengolahan sosis berbasis meat by-product sapi (Hasanuddin University)

[15] Yasin A W N 2011 Pengaruh pengkomposisian dan penyimpanan daging terhadap perubahan karakteristik surimi ikan pari (Trygon sp.) dan ikan kembung (Rastrilliger sp.)

[16] Hemung B-O 2013 Properties of tilapia bone powder and its calcium bioavailability based on transglutaminase assay Int. J. Biosci. Biochem. Bioinforma. 3 306
[17] Boran G and t Karaçam H 2011 Seasonal changes in proximate composition of some fish species from the Black Sea *Turkish J. Fish. Aquat. Sci.* 11 1–5

[18] Suseno S H, Syari C, Zakiyah E R, Jacoeb A M and Izaki A F 2014 Chemical composition and fatty acid profile of small pelagic fish (Amblygaster sirm and Sardinella gibbosa) from Muara Angke, Indonesia *Orient. J. Chem.* 30 1153–8

[19] Shim K, Yoon N, Lim C, Kim M, Kang S, Choi K and Oh T 2017 Relationship between Seasonal Variations in Body and Proximate Compositions of Chub Mackerel Scomber japonicas from the Korean Coast *Turkish J. Fish. Aquat. Sci.* 17 735–44

[20] Shon J, Eo J-H, Hwang S J and Eun J-B 2011 Effect of processing conditions on functional properties of collagen powder from skate (Raja kenojei) skins *Food Sci. Biotechnol.* 20 99–106

[21] Nagai T and Suzuki N 2000 Isolation of collagen from fish waste material—skin, bone and fins *Food Chem.* 68 277–81

[22] Nur’aenah N 2013 Ekstraksi dan karakterisasi kolagen dan nanopartikel kolagen dari kulit ikan pari (Pastinachus solocirostris) sebagai bahan baku kosmetik *Bogor Inst. Pertan. Bogor*

[23] Njinkoue J M, Gouado I, Tchoumbougna Ngueguim J H Y, Ndinteh D T, Fomogne-Fodjo C Y and Schweigert F J 2016 Proximate composition, mineral content and fatty acid profile of two marine fishes from Cameroonian coast: Pseudotolithus typus (Bleeker, 1863) and Pseudotolithus elongatus (Bowdich, 1825) *NFS J.* 4 27–31

[24] Moeljanto 1994 *Pengawetan dan pengolahan hasil perikanan* (Swadaya)