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CHARACTERIZATION OF FATTY ACID FROM BY PRODUCT OF SKIPJACKTUNA (*Katsuwonus pelamis*)

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Abstract

Fisheries production volume increased to 345.130 ton in 2011 (KKP 2012). The favorite and abundant product is smoked fish. Smoked fish processing is very traditional, and produces considerable waste. 40-60% waste are usually dumped directly to sewage system. The study objective are utilization of tuna wastecharacteristic. The result showed the first phase had a total yield of 35.08%. The nutrient content are moisture (head 76.33%), fat (gonads 3.83%), protein (skin 24.08%) and ash (head 5.66%). The heavy metals residue were still inside the safe thresholds of Indonesian National Standard., The identification of fatty acids obtained 30 types of fatty acids. The highest content of SFA are palmitic acid (18,09%) recovered from the head, MUFA are oleic acid (11,96%) also recovered from the head, and PUFA are DHA (30,10%) recovered from gonad. By-product from gonad also have the best yield for fatty acid as much as 68,75%.

Keywords:*By-product, Fatty acids,Mineral, Nutrient.*

Introduction

Atunafisheryresourcesarerelatively abundant, so thatthe commodityhas been developedby the communityas aprocessed productthat issmoked fishandsaltedfish. In general,smokedtunaprocessingthe meatwhileonlyutilizingby-products(heads, skin, intestine, liver, andgonads) are generallydischargeddirectlyintothe sewage systemordisposed ofalong withthe garbage.

Tunaby-producthashuge potentialbecause it containsfatand protein sources. One result ofthe utilization ofby-products tunaisbekasangby fermentation. BekasangThisproductcan be accepted bythe publicbecause ofthe storageup to 7months. Besides its useas abekasangproducts, tunais also expectedto havemost of thecontent ofunsaturated fatty acids, especiallyomega-3 fattyacids. Venugopal(2010) said thatomega-3 fattyacidsfound infatty fishamong others; tuna, herring, mackerel,sardinesandsalmon. AccordingIstiqomah(1998) meattunaoilwithEPAresulted in4.85%(w/w) andDHAamounted to28.59% (w/w), while according toElisabeth(1997) that thecontent oftunafishoiltofatty acidEPA(eikosapentanoatacid) of about 3.64% (w/w) andDHA(acid dokosaheksanoat) approximately14.64% (w/w).

The benefitsandfunctionsofomega-3 fattyacidsare essentialto the human bodyincluding;linolenicfattyacids(omega-3) is usedtomaintainthe structural partsof cell membranes, as well as havingan important functionin brain development, thenEPA(eicosapentaenoicacid) andDHA(docosahexaenoicacid) is useful toeducate the brain, helpinginfancyandlower triglyceride levels(Leblanc etal. 2008). Further it is saidalsobyImreandSahgk(1997), thatsome of the benefitsof omega 3 fattyacidsareable tocurediabetes, atherosclerosis, cancer prevention, andstrengthen the immune system. Besidesomega-3 fattyacids(EPA-DHA) is anessential fatty acidthatthe bodycan not be synthesizedbutderivedfromthe food diet by fish. So theprovision offood productsrich inomega-3 fattyacidsare very important. Thus, the characterizationwill beperformedon thefattyacidby-productof tuna.

Methods and Stages Ofresearch

The mainmatrialof thisresearcharea by-productof tuna(head, skin, intestine, liverandgonads), as well asotherchemicalanalysis. While theeqmpment used areGasChromatography(GC) with a Shimadzu 2010 Plusexternal standard37 supello Farme, preparation tool sand other analytical chemistrytools.

This study beginsbytakingthe rawmaterial(tuna) field, thenpreparedwhichaims togeteach oftunaby-productof the head, skin, intestine, liverandgonads. Thenanalyzedthe content ofthe proximate(Water, Ash, Fat and Protein) AOAC 2005, heavymetal content(BSN 2009), anddetermine thefattyacid profile(AOAC 1999).

Results and Discussion

ProximateBy-productContent ofTuna(Katsuwonuspelamis)

Proximatecontentis an important indicatorthat determinesthe quality ofthe rawmaterialfreshness. The method usedis basedonchemicalanalysis, among others, determine themoisture content, ash content, fat content, and protein contentof each oftunaby-product. The results ofproximatecontent ofeachcanof tunafishwasteare presentedin Table1.

Table1 Proximate composition of by-products

By-product	Proximate percentage (%)			
	Water content	Fat content	Protein content	Ash content
Head	76,33	1,10	16,76	5,66
Intestine	73,51	1,58	18,52	1,38
Skin	71,38	2,00	24,08	2,28
Liver	76,12	1,99	20,34	1,46
Gonads	68,63	3,83	16,75	1,36

The results showed that the content of proximate average water content of 68.63 to 76.38%. Santoso (1998) said that the diversity of the chemical composition due to dietary factors, species, sex, and age of the fish and the same time of the arrest. According Oceanlink (2006) that the biota in having a variety of ways to adapt to the marine environment are minimal food and high pressure, one of which is to increase the percentage of water content.

The results of the fat content of the by-product of tuna showed an average value of 1.10 to 3.83%. These results are consistent with studies conducted by the United States Department of Agriculture (2009) which produces lipid content in tuna 1-3%. It is suspected that more tuna conduct their activities so that the fat content is very much removed rather than stored. Bligh et al. (1988) said variation in the amount of fat content is influenced by the place of life, of the season, a source of food, activity, growth phase. Furthermore, Gehring et al. (2009) also said that the fat content in the fish muscle vary widely. It really depends on the species, age, spawning, feeding and muscle type. Then Jobling (1994), and Gokce et al . (2004) said that the percentage of body fat is also associated with the life cycle and energy intake of the animal.

Protein content of the fish is the largest component in the amount after water content. The results showed that the protein content of tuna by-product average of 16.75 to 24.08%. According to Winarno et al. (1993) that in addition to the meat protein content is also found in fish fins, skin, blood, muscle pigment, liver cells, kidney and stomach contents parts and almost entirely of protein. The results of the percentage of protein content is similar to the results carried out by the United States Department of Agriculture (2009) which resulted in an average protein content of 18-20% . The high protein content is influenced by the species, the environment and food. Fish is also consumed as a source of animal protein because it has a shorter fiber protein that is easily digested by the body and diabsopsi (Fanny 2005).

While the ash content is an inorganic substance residual combustion products of a large amount of organic matter and minerals contained in these materials. The results showed that the ash content of fish by-products calakang have averaged 1.36 to 5.66%. It is thought there are many mineral deposits in the form of organic or inorganic high enough tuna head section. According to the research Harbers and Nielsen (2003) as well as Winarno (2008) that the mineral salts could be organic and inorganic salts. Minerals are sometimes shaped as organic compounds that are complex and difficult to determine the amount in pure form.

The high ash content and composition depending on the food. Compositional variations can occur between species, between individuals within a species and between body parts to one another (Nurjanah et al. 2009). This variation can be caused by several factors, including season, size, stage of maturity, the ambient temperature and availability of food (Sudhakar et al. 2009).

The Content ofHeavyMetalBy-productof Tuna(KatsuwonusPelamis)

Heavymetal contentof theby-producttestedtuna, among others; lead (Pb), mercury(Hg), arsenic(As) andnickel(Ni). Severalnational andinternationalstandardizationin thecontent ofheavy metalsthat are still insuchthresholdisIFOSstandardsin 2011(≤ 0.01 ppm), in 1989the WHOstandards(≤ 0.5ppmforPb), the European Communitystandardsin 2005(≤ 0.2ppmforPb), FAOstandards(≤ 0.1ppmforHg, Pb≤1.00ppm) andstandardBSN(≤ 1.00ppmforPb, Hg, As andNi).

The results showedthatall theby-productsof tunacontain heavy metalsthatare relativelylowanddibatassafethreshold. The results ofthe heavymetal contentof eachby-productof tunacan bepresentedin Table2.

Table 2 Heavy metal residue of by-products

By-product	Heavy metals residue (ppm)			
	Lead (Pb)	Mercury (Hg)	Arsen (As)	Nikel (Ni)
Head	0.68±0.08	0.10±0.00	TTD	TTD
Intestine	0.18±0.06	0.56±0.00	TTD	TTD
Liver	0.45±0.09	TTD	TTD	TTD
Gonads	0.30±0.03	0.31±0.00	TTD	TTD
Skin	0.21±0.05	0.28±0.00	TTD	TTD
NAB	1.00	1.00	1.00	1.00

Keterangan: ppm (*parts per million*), NAB (threshold value), TTD (undetected)

FromTable2showsthat thevaluesof heavy metalsintunafishby-productsare stillon the verge ofa safelimit. It isdefinedbythe nationalstandards bodies. The lowcontent ofheavymetalsin the body ofthe fishis becausethe lower thecontent ofheavymetalthat accumulatesin the body tissuesof fish. Overallthis conditioncannotendangerthe lives ofaquaticbiota, andnotharmful toall living organisms.

Fatty Acid Profile

Determination of fatty acid profile which uses the principle of the method used to change the fatty acids into derivatives, namely methyl esters that can be detected by means of chromatography. Gas chromatography (GC) has a working principle of separation between the gas and the liquid film is based on different types of materials (Fardiaz 1989). The results of the analysis will be recorded on a sheet that is connected to the recorder and demonstrated through several peaks at the retention time specified in accordance with the character of each fatty acid. Prior to injection of methyl esters, extracted the fat first and then do the methylation of material to form the methyl ester of each fatty acid were obtained

The results showed that the by-product of tuna contains 3 fatty acids are unsaturated fatty acids (Saturated Fatty Acid/SFA), monounsaturated fatty acids (Monounsaturated Fatty Acid/MUFA) and polyunsaturated fatty acids (Polyunsaturated Fatty Acid/PUFA). These results identify 32 types of fatty acids are composed of 14 types of fatty acids SFA, 7 types of fatty acids MUFA and PUFA fatty acids 11.

The types of saturated fatty acids (SFA) is capric (C10:0) ,lauric (C12:0) , myristic (C14:0), plamitat (C16:0), stearic (C18:0). Monounsaturated fatty acids (MUFA) oleic acid (C18:1n-9) and palmitoleic (C16:1), whereas Polyunsaturated fatty acids (PUFA), namely EPA (C20:5n-3), DHA (C22:6n-3), linoleic (C18:2n-6) and linolenic (C18:3n-3). Results of the content of the fatty acid profile of tuna by-product can be presented in Table 3 content of saturated fatty acid profile and Table 4 content of unsaturated fatty acid profile.

Table3Saturated fatty acid profile of by-products.

Saturated fatty acid (SFA)	Structure	By-product percentage(%)				
		Head	Skin	Intestine	Liver	Gonads
Caprilic acid	C8:0	-	-	-	0,34	-
Capric acid	C10:0	-	-	-	0,21	-
Lauric acid	C12:0	0,06	0,03	0,02	0,14	-
Tridecanoic acid	C13:0	0,06	0,04	-	-	-
Myristic acid	C14:0	2,85	2,29	0,47	0,62	0,49
Pentadecanoic acid	C15:0	0,91	0,73	0,27	0,59	0,39
Palmitic acid	C16:0	18,09	15,66	8,89	16,9	13,11
Heptadecanoic acid	C17:0	1,21	0,99	0,53	0,87	0,67
Stearic acid	C18:0	6,46	6,04	6,04	5,41	6,09
Arachidic acid	C20:0	0,42	0,4	0,13	0,29	0,12
Heneicosanoic acid	C21:0	0,12	0,12	0,03	0,06	0,04
Behenic acid	C22:0	0,26	0,26	0,22	0,76	0,18
Tricosanoic acid	C23:0	0,10	0,09	0,08	0,11	0,08
Lignoceric acid	C24:0	0,28	0,20	0,27	0,26	0,14
Total SFA		**30,82**	**26,85**	**16,95**	**26,56**	**21,31**

The results showed that the highest amount of saturated fatty acid content of the by-product of tuna is a fatty acid palmitic (C16:0) chief among them 30.82%, 26.85% skin, intestinal 16.95%, 26.56% and liver gonadal 21.31%. Fatty acids are the basic components of SFA fat formation system of living beings so high palmitic fatty acids caused by palmitate are precursors for long-chain fatty acids through the process of elongation or denaturation. The total value of the highest saturated fatty acids contained in the head by 30.82%.

Tabel 4Unsaturated fatty acid profile of by-products.

Monounsaturated Fatty Acid (MUFA)	Structure	By-product percentage(%)				
		Head	Skin	Intestine	Liver	Gonads
Myristoleic acid	C14:1	0,04	0,03	-	-	-
Palmitoleic acid	C16:1	3,80	3,21	1,01	0,91	0,96
Elaidic acid	C18:1n9t	0,20	0,14	0,07	0,10	0,07
Oleic acid	C18:1n9c	11,96	10,29	4,92	3,31	4,29
Cis-11-Eicosenoic Acid	C20:1	0,86	0,68	0,16	0,16	0,19
Erucic acid	C22:1n9	0,30	0,13	0,05	0,05	0,05
Nervonic acid	C24:1	0,60	0,73	0,76	0,32	0,38
Total MUFA		**17,76**	**15,21**	**6,97**	**4,85**	**5,94**

Polyunsaturated Fatty Acid (PUFA)	Structure	By-product percentage(%)				
		Head	Skin	Intestine	Liver	Gonads
Linolelaidic acid	C18:2n9t	0,04	0,04	0,20	0,04	0,10
Linoleic acid	C18:2n6c	1,01	0,99	0,55	0,65	0,66
γ-Linolenic acid	C18:3n6	0,08	0,11	0,02	-	0,04
α-Linolenic acid	C18:3n3	0,24	0,38	0,11	0,07	0,15
Eicosetrienoic acid	C20:3n3	0,20	0,10	0,06	0,04	0,11
Arachidonic acid	C20:4n6	1,30	1,60	4,97	1,58	5,89
Eicosedienoic acid	C20:2	0,27	0,35	0,13	0,15	0,18
Eicosetrienoic acid	C20:3n6	0,07	0,10	0,13	0,07	0,11
Eicosapentaenoic acid	C20:5n3	1,87	2,50	2,82	1,03	4,13
Docosadienoic acid	C22:2	0,02	0,04	0,03	-	0,03
Docosahexaenoic acid	C22:6n3	11,33	18,89	16,42	3,28	30,10
Total PUFA		**16,41**	**25,10**	**25,44**	**6,91**	**41,50**

The results showed that the highest amount of unsaturated fatty acid content of the by-product single tuna is a fatty acid oleic (C18:1n9c) including; heads of 17.76%, 15.21% leather, 6.97% intestine, liver 4,85% and 5.94% gonads. While fatty acids are polyunsaturated fatty acids docosahexaenoic (DHA = C22:6n3) including; heads of 16.41%, 25.10% skin, intestinal 25.44%, 6.91% liver and gonads 41.50%.

In Table 4 shows the fatty acids DHA (omega -3) higher compared with oleic fatty acids (omega-9). This is presumably because tuna are many foods that can synthesize omega-3 such as phytoplankton , rather than consume small fish or crustaceans which contains oleic (omega-9). Kusumo (1997) said that the difference in the levels and composition of fatty acids is very possible because the composition of fats and fatty acids in fish depends on the type of species, habitats and types of food consumed by the fish. Furthermore, also said that the pelagic fish activity is high enough to require considerable energy. With the presence of omega- 3 fatty acids is high potential energy reserves to support high activity.

Then some other studies reported that the temperature decrease strongly correlated with increasing content of PUFA in fish tissue and also contains omega-3 in salmon (Izquierdo 2005 and Miller 2007). Ibeas et al. (2000), Yildiz (2008), said that the fish do not have the enzyme systems such as that of the freshwater fish that saltwater fish require very long chain fatty acids omega-3 and omega-6 from feed for optimum growth Further research results Lall (2000), Balfry and Higgs (2001), Place and Harel (2006) reported that the increased content of PUFA, especially DHA (omega-3) when the salinity increased, thus indicating the importance of the role of these fatty acids on the regulation of osmoregulation and resistance to stress.

Essential fatty acids, especially omega-3 plays a very important for health. According to Abadi (2007) that the function of omega-3 fatty acids as the builders are mostly cerebral cortex of the brain and for the normal growth of this organ, because it is very important to keep the content of omega-3 in the diet .

The highest content of total fatty acids, respectively tuna by-product, starting from the gonads (68.75%), skin (67.16%), head (64.99%), colon (49.36%) and liver (38.32%). From all the results of the fatty acid content, which is the predominant fatty acid DHA (omega-3). Then have obtained also some unidentified fatty acids from tuna by-products including; capric fatty acids (head, skin, gut and gonads), lauric fatty acid (gonads), and linoleic fatty acids (liver). Absence of fatty acids were identified by-products, presumably because of the fatty acid content is very low. The low fatty acid causes the peak (Peak) small fatty acids that can not be distinguished from the gas chromatographic peak nois influence or damage has occurred methylation of fatty acids in the fat phase.

Conclusion and Recommendations

Conclusion

Based on these results it is concluded among other things:

1. The content of the highest proximate tuna by-products including; moisture content of 76.33% (head), fat content 3.83% (gonads), the protein content of 24.08% (skin) and ash content of 5.66% (head).
2. Based on national standards bodies (2009), in which the heavy metal content contained in by-product of tuna are below the safe limit of 1.00 ppm verge.
3. Fatty acid content of tuna by-product generated in which the content of omega-3 fatty acids (DHA) and EPA amounted to 30.10% of 4.13%, while the content of omega-9 fatty acids (oleic) of 11.96% and palmitic fatty acid content of 18.09%.
4. The highest total fatty acid content by-product produced by the gonads of 68.75%.

Suggestion.

1. It should be further research in order to obtain and provide information other mineral content in the body of tuna and fat content variation is affected by species, age, spawning, feeding and muscle type.
2. It should be made use of the content of omega-3 fatty acids as a food product for human health.

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