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Fatty acid profile of fish from Central Sulawesi, Indonesia

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Abstract

This study was conducted to determine the fatty acid profiles (omega3, 6 and 9) of five fish from Central Sulawesi, Indonesia. Fish species used as sample in this study were small yellow striped scad (*Selaroides* spp.), indian scad (*Decapterus* spp.), tuna (*Euthynnus* spp.), snapper (*Lutjanus* spp.) and catfish (*Clarias* spp.). Fish oils were obtained using the wet rendering method, followed by fatty acid profile analysis by gas chromatography. The results showed that the highest omega3 was observed in fish oil of small yellow striped scad (*Selaroides* spp) (24.45%) especially eicosatrinoic fatty acid (16.99%), while the highest content of omega6 were found in tuna (*Euthynnus* spp.) fish oil (11.72%), and catfish (*Clarias* spp.) fish oils contained the highest content of omega9 (34.96%). It is interesting to note that the fatty acids profile showed the most abundant acid was palmitic for all samples, in the range of 25.00 – 36.01%. It can be can concluded that these fish oils are a potential resource for omega3, 6 and 9 especially in fish oils of small yellow striped scad and catfish.

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Introduction

The potential of fisheries resources in the sea water of Central Sulawesi is about 330,000 tons per years, with sustainable management about 214,108 tons per year which consists of different types of fish, shrimp, squid, sea shells, seaweed and pearls. The production of capture fisheries is 196.108 tons per year which consist of large pelagic and small pelagic fish, such as tuna (*Catsuwonus pelamis*), king fish (*Scomberomonus commerson*), big yellow striped scad (*Selaroides* spp) and small pelagic fish such as tuna (*Euthynnus* spp), indian scads (*Decapterus* spp), small yellow striped scad (*Selaroides* spp), sardine (*Sardina pilchardus*), while the kind of demersal fish such as snapper (*Lutjanus* sp), mackerel (*Scomberomorus commerson*), grouper (*Serranidae perciformes*) and others (Anonymous, 2012a). Meanwhile the type and amount of aquaculture production like goldfish (*Cyprinus carpio*) 2,182 tons, catfish (*Pangasius pangasius*) 1,833 tons, catfish (*Clarias* sp) 35 tons, tilapia fish (*Oreochromis niloticus*) 1 ton, pamfret fish (*Pampus argentus*) 2 tons, tilapia fish (*Oreochromis mossambicus*) is 240 tons (Anonymous, 2012b).

Different kind of fish could be found in Central Sulawesi, therefore this condition greatly influence the society consumption patterns. As an example the community of Palu City prefer demersal fish rather than pelagic fish, therefore pelagic fish becomes less economical (Anonymous, 2012a).

Fish is one of essential nutrient source for the process of human survival. Human have utilized fishes as food material since several centuries ago due of several nutrients such as protein, fat, vitamin and mineral. Fat contained in fish is unsaturated fatty acid known as omega3 which can strengthen the brain (Simopoulos, 2002; Steffens, 2006; Fawole *et al*., 2007). Kolanowski (2005) noted that human bodies change omega3 into an acid called docohexaenoic acid (DHA) which can be made as the nutrient for the development of the brain and nerve cells. Furthermore, Steffen and Wirth (2005) also noted the omega3 poly-unsaturated fatty acids have an antiatherosclerotic effect the inhibition of synthesis of the vasoaggressive low density lipoprotein (LDL) and no influence on the vasoprotective hight density lipoprotein (HDL) or even enchanged HDL production. On the other hand, it can be used for therapy of children who experience hyperactivity and mental disorders, such as Obsessive-Compulsive Disorder (OCD), depression, and also good for alzeimer patients (Bays and Lansing, 1994; Nestel, 2000; Ackman, 2002; Mohamed and Gamal, 2011).

The contituent of its fatty acid, namely saturated fatty acid (SFA) and unsaturated fatty acid contained mono-unsaturated fatty acid (MUFAs) and poly-unsaturated fatty acid (PUFAs) or high unsaturated fatty acid (HUFAs) known as omega3,omega6 and omega9 could affect the oil properties (Simopoulos, 2002; Kolanowski, 2005).

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Fish oil generally contained omega3 (eicopenthanoic acid, docohexaenoic acid), omega6 (linoleic acid and arachidoneic acid) and omega9 (oleic acid) which believed have a healthy beneficial as noted by Calder (1996); Massaro *et al.* (1999); Cleland *et al.* (2003) and Ruxton *et al.* (2004). Intensive studies on omega3,6,9 and cholesterol content as well as fatty acids profile of some sea water and freshwater fish had been carried out by some researches (Ugoala *et al*., 2008; Yildiz, 2009; Adeniyi *et al*., 2012; Luczynska *et al.*, 2012). However, fish oil extracted from sea water and fresh water fish of central Sulawesi province have not been investigated. Therefore the aim of this study was to find out the omega3,6,9 content and fatty acids profile of five different fish oils extracted from sea and fresh water fish of central Sulawesi Province.

Materials and Methods

Samples for laboratory analysis

Five kind of non-economical fish namely small yellow striped scad (*Selaroides* spp.), Indian scad (*Decapterus* spp.), tuna (*Euthynnus* spp.), snapper (*Lutjanus* spp.) were obtained from sea water of Makassar or Tomini Gulf (Parimo Regency) and catfish (*Clarias* spp.) from fresh water in the city of Palu, Central Sulawesi Province. Average weight of each fish was 300-500 g. These fish oils were extracted by wet rendering method (AOAC, 2000) and omega3, 6 and 9 was determined using the method described in AOAC (2000).

Analysis of fatty acids

Samples of fish oil before fatty acids profile analysed were converted to their constituents FAMEs following the method as described in AOAC (2000). Oil samples (0.3 ml) were methylated using 1.5 ml of Na-Metanolic and heated at 65°C for 15 minutes in waterbath. 1.5 ml of BF_3-Methanol were added to the mixture, then heated at the same condition and the solution was allowed to cool down up to ambient temperature. The solution was extracted with 0.5 ml of N-Heptane and 1 ml of saturated NaCl, and the top-layer of solution (1 µl) was injected to Gas Chromatography (at the same condition with standard) as described in AOAC (2000). The GC used in this analysis was equipped with split injector mode at 260°C, and He as carier gas with pressure 234 kPa and total flow 62.6 mL/min,column flow 2.84 mL/min, purge flow 3.0 mL/min and linear velocity of 56.8 cm/sec. The Column used was Rtx-5 serial number 796380 , column length 30.0 m, film thickness 0.25 µm, inner diameter 0.25 mm ID and column temperature 340°C. While the column oven initial temperature was range 140°C with equilibration time 1 min. and temperature program was from 140 to 240°C with holding time from 5 - 60 min.

Statistical analysis

All data were expressed as means ± sd (n = 3). For the fatty acids profile were design using Completely Randomized Design, and continued with Turkey's HSD (Honestly Significant Difference) test. All the above mentioned statistical analyses were performed using SPSS statistical software (version 10 for windows) and differences were considered statistically significant at $P < 0.05$ (Steel and Torrie, 1993).

Results and Discussion

Omega3 extracted from small yellow striped scad (*Selaroides* spp.) fish oil was found the highest content (24.45%), while the highest amount of omega6 was found from tuna (*Euthynnus* spp.) fish oil (11.72%) and the highest amount of omega9 was found from catfish (*Clarias* spp.) fish oil (34.96%). The omega3, 6, and 9 contents of fish oil from five different species is presented in Table 1 showing that the omega3, 6 and 9 contents of fish oil samples were different between fish species.

Honestly Significant Different (HSD) test results showed that omega3 content of small yellow striped scad (*Selaroides* spp.) fish oil was higher than indian scad (*Decapterus* spp.) fish oil, tuna (*Euthynnus* spp.) fish oil, snapper (*Lutjanus* spp.) fish oil and catfish (*Clarias* spp.) fish oil. These differences are believed affected by climate, temperature, rainfall and water current. Life cycle such as species, sex, weight, size, reproductive and especially the feeding system are also greatly affected the fish food and diet (Endinkeau and Tan, 1993; Nowsad *et al*., 2012; De Oliveira *et al*., 2013). Furthermore, Catherine *et al.* (2011) also noted that these type of fish could swim to surface up to the dept of 200 m. Ugoala *et al.* (2008) reported that fresh water fish like catfish (*Clarias* sp) is a lenitic or basin series fish which live in lake, reservoirs and ponds. These conditions are also believed affected the omega3, 6 and 9 contents of those fish.

Fatty acids profile of five different fish oil determined using Gas Chromatography are presented in Table 1. The mono-unsaturated fatty acid (MUFA) of the fish oil with fairly high oleic acid (C18:1n9) was observed higher in catfish (*Clarias* spp.) fish oil (34.96%), and it was higher than tuna (*Euthynnus* spp.) fish oil (17.38%), indian scad (*Decapterus* spp.) fish oil (16.35%), small yellow striped scad

Table 1. Fatty acids profile (% total fatty acids), SFA, MUFA, PUFA (%) and the content omega3, 6, 9 (%) of five different fish oil

Fatty Acids	*Selaroides* spp	*Decapterus* spp	*Euthynnus* spp	*Lutjanus* sp	*Clarias* sp
C6 : 0	0 0	0 0	0 0	0 0	0 0
C8 : 0	0 0	0 0	0 0	0.04 ± 0.04	0 0
C12 : 0	0.10 ± 0.18	0.12 ± 0.06	0.25 ± 0.26	1.98± 1.94	1.98 ± 0.04
C13 : 0	0.11 ± 0.13	0.11 ± 0.07	0.09 ± 0.08	0 0	0.01 ± 0.00
C14 : 1	0.03 ± 0.04	0.06 ± 0.05	5.81 ± 0.49	4.63 ± 0.05	0.05 ± 0.00
C15 : 0	1.69 ± 1.17	1.92 ± 0.76	1.44 ± 0.96	0.21 ± 0.01	0.21 ± 0.00
C14 : 0	7.11 ± 0.94	7.18 ± 0.25	11.68± 0.19	12.50 ± 1.95	1.99 ± 0.04
C16 : 1	8.18 ± 0.58	9.52 ± 0.26	9.17 ± 0.51	8.95 ± 1.17	4.95 ± 0.07
C16 : 0	29.36 ± 1.09	36.01 ± 0.57	32.90± 0.07	27.86 ± 1.62	25.00 ± 0.41
C17 : 0	0.19 ± 0.18	0.21 ± 0.19	0.05 ± 0.05	0.05 ± 0.00	0 0
C17 : 1	2.36 ± 0.42	2.59 ± 0.09	2.49 ± 0.37	1.66 ± 0.17	0.00 ± 0.00
C18 : 0	3.01 ± 0.58	3.29 ± 0.18	3.72 ± 0.49	3.36 ± 0.30	22.95 ± 1.35
C18 : 2	0.42 ± 0.26	0.62 ± 0.76	0.59 ± 0.47	0.75 ± 0.12	0.00 ± 0
C18 : 3n3	1.53 ± 0.26	11.08 ± 0.97	12.3 ± 0.2	2.38 ± 0.02	0.86 ± 0.52
C20 : 3n3	16.99 ± 1.25	0.04 ± 0.10	0.08 ± 0.11	0.04 ± 0.06	0.00 ± 0
C24 : 1	0.99 ± 0.95	0.58 ± 0.61	0.47 ± 0.5	0.07 ± 0.07	0.05 ± 0.04
C22 : 6n3	0.34 ± 0.33	0.32 ± 0.28	0.27 ± 0.33	0.34 ± 0.06	0.00 ± 0.02
C20 : 5n3	0.23 ± 0.22	0.20 ± 0.14	0.15 ± 0.15	0.17 ± 0.08	0.12 ± 0.02
C20 : 4n3	5.36 ± 0.17	0.19 ± 2.37	0.87 ± 9.29	9.30± 0.08	0.12 ± 0.04
C20 : 0	6.30 ± 1.02	8.15 ± 0.52	5.17 ± 2.81	2.95± 0.07	0 0
C18 : 2n6	10.53 ± 0.87	10.71 ± 0.82	11.73 ± 1.44	11.03 ± 0.35	6.29 ± 0.10
C18 : 1n9	14.52 ± 0.93	16.35 ± 0.38	17.38 ± 1.64	4.33± 0.83	34.96 ± 1.48
SFA	47.87	56.98	55.30	48.95	52.19
MUFA	26.08	29.09	35.34	19.64	40.02
PUFA	35.4	23.16	25.29	22.23	7.39
Omega-3	24.45^{a} ± 1.45	11.79^{b} ± 0.68	15.98^{a} ± 3.48	12.19 ^{a}± 3.29	1.18^{c} ± 0.74
Omega-6	10.53^{b} ± 0.87	10.71^{b} ± 0.21	11.73^{b} ± 1.49	11.03 ^{a}± 0.69	6.29^{b} ± 0.10
Omega-9	14.52^{b} ± 0.93	16.35^{a} ± 0.58	17.38^{a} ± 1.61	4.33^{b} ± 0.83	34.96^{a}± 1.49

All values are means of three replication (average ± Standard deviation), in the same column accompanied with different letters are significantly different ($P \leq 0.01$)

(*Selaroides* spp.) fish oil (14.52%), and snapper (*Lutjanus* spp.) fish oil (4.33%). While fish oil with fairly high palmitooleic acid (C16:1) was observed in indian scad (*Decapterus* spp.) fish oil (9.52%), and it was higher than tuna (*Euthynnus* spp.) fish oil (9.17%), snapper (*Lutjanus* spp.) fish oil (8.95%), small yellow striped scad (*Selaroides* spp.) fish oil (8.18%) and catfish (*Clarias* spp.) fish oil (4.95%). Meanwhile, tuna (*Euthynnus* spp.) fish oil was higher in PUFA content and it was characterized by high linolenic acid (C18:3n3) and linoleic acids (C18:2n6) fish oil (12.3% and 11.73%), indian scad (*Decapterus* spp.) fish oil (11.08% and 10.71%), compared to snapper (*Lutjanus* spp.) fish oil (2.38% and 11.03%), small yellow striped scad (*Selaroides* spp) (1.53% and 10.53%) and catfish (*Clarias* spp.) fish oil (0.86% and 6.29%) respectively. For saturated fatty acid (SFA), palmitic acid (C16:0) was the dominant fatty acid observed in indian scad (*Decapterus* spp) fish oil (36.01%), compared to tuna (*Euthynnus* spp.) fish oil (32.9%), small yellow striped scad (*Selaroides* spp.) fish oil (29.36%), snapper (*Lutjanus* spp.) fish oil (27.86%), catfish (*Clarias* spp.) fish oil (25.00%). Sample from small yellow striped scad (*Selaroides* spp) fish oil contained a very high PUFA compared to other samples (Table 1). The eicosatrinoic acid (C20:3n3) of small yellow striped scad (*Selaroides* spp) amount was around about 16.98 times compared to tuna (*Euthynnus* spp.) fish oil, indian scad (*Decapterus* spp) fish oil, snapper (*Lutjanus* spp.) fish oil, and catfish (*Clarias* spp.) fish oil. On the other hand catfish (*Clarias* sp) fish oil had a very high oleic acid (C18:1n9) MUFA content was about 17.57 times than tuna (*Euthynus* spp.) fish oil, and about 18.63 times than indian scad (*Decapterus* spp) fish oil, and about 20.45 times than small yellow striped scad (*Selaroides* spp.) fish oil, and also about 30.63 times than snapper (*Lutjanus* spp.) fish oil.

Nurnadia *et al.* (2013) also observed similar amount of MUFA and PUFA in demersal and pelagic fish in their study. They reported that mono-unsaturated fatty acids (MUFAs) C18:1n9 (Oleic acid) from Yellowstrip scad fish oil 188.8 mg/100 g, Indian mackerel fish oil 294.8 mg/100 g, Malabar red snapper fish oil 141.8 mg/100 g, Gray eel-catfish 103.7 mg/100 g. While poly-unsaturated fatty acid (PUFAs) C18:2n6 (linoleic acid) from Yellow strip scad fish oil 113.6 mg/100 g, Indian mackerel fish oil 29.3 mg/100 g, Malabar red snapper fish oil 60.4 mg/100 g, Gray eel-catfish 133.6 mg/100 g. Meanwhile saturated fatty acid (SFA) from Yellowstrip scad fish oil about 560.8 mg/100 g, Indian mackerel fish oil 313.7 mg/100 g, Malabar red snapper fish oil 373.7 mg/100 g, Gray eel-catfish 717.8 mg/100 g.

The average content of mono-unsaturated fatty acids (MUFA) especially C19:1n9 (oleic acid), poly-unsaturated acid (PUFA) C18:2n6 (linoleic acid) from different fish species used in this study were lower compared to the average content reported by some other workers. However in this study fish oil of small yellow striped scad (*Selaroides* spp) contained C20:3n3 (eicosatrinoic acid) quite high (16.99%) compared to others fish oil (Table 1) and to other reports of similar fish species and found that their fish oil contained very low eicosatrinoic acid or even in some fish species this acid was not detected (Gutierrez and Da Silva, 1993; Steffens and Wirth, 2005; Yildiz, 2007; Nurnadia *et al*., 2013). This condition could be due to different species and water area as well as catching season as noted by Steffens and Wirth (2005); Swapna *et al.* (2010) and Boran and Karacam (2011).

Nurnadia *et al.* (2013) also reported mono-unsaturated fatty acids (MUFA) content of Red snapper 141.8 mg/100 g, Yellowstripe scad 286.8 mg/100 g, Grey eel catfish 168.1 mg/100 g, Indian mackerel 294.8 mg/100 g, Spanish mackerel 70.6 mg/100 g, and PUFA Red snapper 724.7 mg/100 g, Yellowstripe scad 1417.0 mg/100 g, Grey eel catfish 810.7 mg/100 g, Indian mackerel 190.3 mg/100 g, and Spanish mackerel 314.2 mg/100 g. While SFA of Red snapper 557.9 mg/100 g, Yellowstripe scad 869.6 mg/100 g, Grey eel catfish 1340.8 mg/100 g, Indian mackerel 587.8 mg/100 g and Spanish mackerel 322.8 mg/100 g. On the other hand Luczynska *et al.* (2012) noted that mono-unsaturated (MUFA) content from Rainbow trout fish oil about 35.9%, Carp fish oil (55.0%), Bream fish oil (35.8%) and Tench fish oil (38.3%), while poly-unsaturated fish oil (PUFA) content from Rainbow trout fish oil 39.8%, Carp fish oil (16.2%), Bream fish oil (39.6%) and Tench fish oil (36.5%).

Adesola (2009) reported that mono-unsaturated fatty acids (MUFA) C18:1 (oleic acid) from *Clarias gariepinus* and Tillapia Zillii fish oil were 26.0% and 16.6% respectively, while polyunsaturated fatty acids (PUFA) C 18:2n6 (linoleic acid) 12.3% and 1.4%. Mean while saturated fatty acids (SFA) C16:0) (palmitic acid) were 22.0% and 32.2% respectively.

The value of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were found very low on all kind of fish oil in this study compared to the one reported by Wan Rosli *et al.* (2012). However, similar results were observed with the finding of Wan Rosli *et al.* (2012) that DHA was not available in catfish fish oil. While Hwang *et al*. (2004) reported that EPA and DHA contents in Korean catfish was 3.2% and 6.8% respectively, which is much higher than the one observed in this study.

In this study the fresh water catfish (*Clarias* spp.) fish oil contained quite high amount of omega9 while Steffens and Wirth (2005) observed different results, where in silver carp, bighead carp and grass carp contained high amount of essential poly-unsaturated fatty acid i.e omega3 and omega9 series. Furthermore, fresh water fish oil had an omega3 - omega9 ratio in the triacylglycerol higher compared to the one in marine species.

Conclusion

The highest omega3 was from fish oil of small yellow striped scad (*Selaroides* spp) (24.45%), while the highest content of omega6 were found in tuna (*Euthynnus* spp.) fish oil (11.72%), and catfish (*Clarias* spp.) fish oils contained the highest content of omega9 (34.96%). It is interesting to note that the fatty acids profile showed the most abundant acid was palmitic for all samples, in range of 25.00 – 36.01%. Catfish (*Clarias* sp) as well as marine fish are very potential as natural sources of omega3, 6 and 9.

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