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Proximate, fatty acid and mineral composition of selected deep sea fish species from Southern Java Ocean and Western Sumatra Ocean, Indonesia

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Abstract: Proximate content, fatty acid and mineral compositions were determined for the ten species of deep-sea fish from Southern Java Ocean and Western Sumatra Ocean, Indonesia. The proximate composition was found to be 23.0-24.8 % protein, 1.9-4.1% fat , 0-1.75 % carbohydrate, 1.7-2.4 % ash and 70.1-72.1% water, whereas the fatty acid compositions consisted of 0.86 - 49.63 % saturated fatty acids (SFA), 0.29 - 50.09 % monounsaturated fatty acid (MUFA) and 2.85 % - 46.32 % polyunsaturated fatty acids (PUFAs). Among them, those occurring in the highest proportions were myristic acid (C14:0, 0.12-7.59%), palmitic acid (C16:0, 0.02–20.5%), stearic acid (C18:0, 0.42–49.19), oleic acid (C18:1, 0.29–50.09 %), linoleic acid (C18:2, 0.23–44.91%), eicosapentaenoic acid (EPA, C20:5n3, 0.41– 4.61%) docosahexaenoic acid (DHA, C22:6n3, 0.28–3.44%). The rest of the microelements, Cd, Hg, and Pb were all present in amounts below toxic levels.

Keywords: deep-sea fish, proximate, fatty acid, microelement and macroelement

Introduction

The total prediction of Indonesian fishery ocean potential amounts to 6.6 million tons/year, consisting of 5 million tons in Indonesian Ocean and 2.1 million tons in the Economic Exclusive ocean zone. Of this the small pelagic fish makes up 3.5 million tons and coral fish 0.048 million tons/year (Anonymous, 2000). According to the estimation in "Production and utilization of pelagic fish in Indonesia in 2001", Straits of Melaka and Java Sea are in the state of over fishing (BRKP, 2001). Therefore there is a need to look for new fishing grounds apart from the 'coastal and pelagic areas. An alternative area is the deep sea.

Deep sea area is located under the shining depth area in the open ocean and is deeper than the continental shelf (>200 m). The habitat, seldom inhabited by organisms, is the widest in the world, with its water volume amounting to 85% of 70% world surface (Nybakken, 1992). The rare fishes however, are important food source and often looked for by some people in the markets. In Europe, deep-sea fish (Lunglip) is marketed as cusk eel. In New Zealand it is known as Hung, South America, *Cangrio* and in Japan, *Kingu*. This fish is marketed by retail and rarely appears in restaurants, because of the good quality and unique meat texture. Gold, red and black kinglip are marketed internationally, but the gold and red kinglip are preferred in the USA (Perkins, 1992). In Australia, deep sea fish (*Beryx aplendens*) was exploited, to the extent of over fishing (Anonymous, 2004). In addition Soselia and Rustam (1993) reported that *Cubiceps whiteleggi* is one of economically important fish in the future.

The food consumption and metabolism of deep sea fish have seldom been studied. Information on the proximate content and fatty acid distribution is important when utilization of new species of deep-sea fish is considered. This is because deep-sea fishes are considered to be not only food with good source of quality protein but also food with healthy components. Polyunsaturated fatty acids (FAs) such as eicosapentaenoic acid (EPA, 20:5 (n-3)) and docosahexaenoic (DHA, 22:6 (n-3)) have been recommended for human health and fish fecundity;

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particularly in DHA, has a therapeutic effect on human physiology (Ackman, 1988; Saito et al.,1997). A comparative study of fatty acid profiles and fat content of commercially important seawater and freshwater fish species of Turkey showed that fatty acid profiles of most freshwater fishes are basically comparable to those of seawater fishes as source of PUFAs (Ozagul et al., 2007). Tuna (Bonito *Euthynnus pelamis*) caught at three different localities from the tropics contained docosahexanoic acid (DHA; 22:6n-3) as the major unsaturated fatty acid in the lipid of all the specimens examined (Saito et al., 1997). *Hypopphthalamus* sp from Central Amazonia presented a higher concentration of EPA (20 ± 3 mg/g) and DHA (18 ± 3 mg/g) in the muscular tissue in the wet seasonal period, without a significant difference between the two acids (Inhamus and Franco, 2008).

Production of docosahexanoic acid by marine bacteria isolated from deep sea fishes was reported by Yano et al. (1994) that five bacterial strains isolated from the intestines of deep-sea fishes were shown to produce docosahexanoic acid at levels of 6.4 to 11.6% of the total fatty acid when incubated in DHA free medium.

The result of Baruna Jaya IV expedition led by The Agency for Marine and Fisheries, Research Ministry Marine Affairs and Fisheries, Indonesia showed about 529 kinds of deep-sea fishes in the Southern Java Ocean and Western Sumatra Ocean, Indonesia (BRKP, 2001). The objective of this study was to investigate the proximate content, mineral and fatty acid compositions of deep-sea fishes caught in the Western Sumatra Ocean and the Southern Java Ocean.

Materials and Methods

Fish materials used in this work consisted of 10 species of deep-sea fishes (*Alepocephalus bicolor, Antigonia rubescen, Barbourisia rufa, Caelorinchus divergen, Polymixia sp, Rouleina guentheri, Setarches guentheri, Synagrops japonicus, Tydemania navigatoris* and *Xenolepidichthys dalgleishi*) caught using a trawler at depths of 372 to 1000 m in the Southern Java Ocean and the West Sumatera Ocean, Indonesia in Table 1. The fish samples were kept frozen at -20 0C until analyzed.

Chemical analysis

Moisture content was determined by drying samples in an air circulation oven for 8 h at 100°C. Samples for ash determination were heated in a furnace at 550°C for 6 h to constant weight as described in the AOAC manual (AOAC, 1975). Crude protein was determined on the edible portions of fish from Kjeldahl nitrogen using a 6.25 conversion factor (AOAC, 1975). Lipids were extracted by using chloroform/methanol (2 : 1, v/v) and were gravimetrically determined as described previously (Bligh and Dyer, 1959).

Fatty acid analysis

Preparation of fatty acids methyl ester was carried out according to the method of (Mondello

Table 1. Physical measurements and edible portion of some Deep-Sea Fishes from Southern Java Ocean and Western Sumatra Ocean

Fish Species	Length (cm)	Weight (g)	Depth (m)	Fillet Weight (g)	Edible Portion
Alepocephalus bicolor	29.5	190	500-1000	90,50	47,63
Antigonia rubescens	15	95	1000-4000	27,60	29,05
Barbourisia rufa	37.5	440	300-2000	150,09	34,11
Caelorinchus divergens	49	550	789	170,08	30,92
Polymixia sp	22.5	200	18-700	79,40	39,70
Rouleina guentheri	26.5	210	967	92,00	43,81
Setarches guentheri	28	275	627	100,00	36,36
Synagrops japonicus	17.5	75	388	25,00	33,33
Tydemania navigatoris	14	55	372-373	16,00	29,09
Xenolepidichthys dalgleishi	15.5	60	200-885	28,00	46,67

et al., 2006). Crude oil extract (20 µL) from deep-sea fish samples were trans-esterified in a pyrex tube by using 200 µL of borontrifluoride-methanol (20% BF3) reagent and heating at 100°C for 30 min. After cooling, 200 µL of n-hexane and 800 µL of distilled water were added to the mixture, which was then agitated manually for 1 min and centrifuged for 2 min. Approximately 100 µL of the upper n-hexane layer was transferred to a 150 µL glass insert for 2 ml vials after diluting the extracted hexane to obtain a suitable chromatographic response. Fatty acids were identified by comparing the retention times of FAME mixture with the standard myristic acid palmitic acid, stearic acid, oleic acid, linoleic acid , eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA). Two replicate GC analyses were performed and the results were expressed in GC area % as mean values ± standard deviation. The fatty acid composition of deep-sea fish oil triacyglyserol was directly analyzed using Gas Chromatography (GC) after methylesterification. One µL of each fatty acid methyl ester (FAME) sample was injected (split ratio 15:1) into a GC 17 A-SHIMADZU Gas Chromatography (Shimadzu Scientific Inc., USA) with flame ionization detector (GC-FID). A BPX 70 (SGE, Australia) column consisting of a 30 m x 0.32 mm fused silica capillary coated with 70 % cyanopropyl polysilphenylene-siloxane of 0.25 µm film thickness was used, with Hydrogen as the carrier gas at constant linear velocity (28 cm/s). The injector temperature was 250°C and the detector temperature 280°C. The oven was programmed as follows: 80°C for 2 min, 5°C/min to 200°C for 10 min and 10°C/min to 230°C for a further 10 min. Total analysis time was 49 min and the last major fatty acid (24:1 n-9) was eluted at approximately 30 min. Chromatographic peaks were identified by comparing retention times with the PUFA standard.

Results and Discussions

Edible portion

The chemical composition of the edible portion of ten deep sea fish species at the Table 1 showed that edible portion of some deep sea fish examined were 29, 05-47, 63%. According to Belitz and Grosch (1986); Ilyas (1983) for pelagic fish were 45-75% and 30-70% respectively. In general they have a smaller size than the pelagic fish so that it effected to the edible portion (Oceanlink, 2006).

Proximate composition of the fish muscle

The moisture, protein, fat and ash contents in the muscles of the deep-sea fishes *Alepocephalus bicolor, Antigonia rubescen, Barbourisia rufa, Caelorinchus divergen, Polymixia sp, Rouleina guentheri, Setarches guentheri, Synagrops japonicus, Tydemania navigatoris,* and *Xenolepidichthys dalgleishi* examined are shown in Table 2. The moisture content was between 73.29% and 82.73%, protein content was between 11.94 % and 20.58 %, fat content ranged from 0.01% to 4.84% and ash was from 1.03 to 2.48%. This result is similar to the proximate test results for deep-sea fish species reported previously (Okland et al., 2005). The protein content of *Polymixia* sp was the highest of the deep-sea fishes examined. The protein contents of the deep-sea fishes examined were similar to commercially important fish species from the Black Sea previously reported by Guner et al. (1998), as well as to that reported by Okland et al. (2005). According to Stanby and Olcott (1963), deep-sea fishes are high in protein and low in fat, compared to pelagic fish, a finding that is confirmed in the present study.

In terms of the lipid content, the deep-sea fish examined can be considered to be in the low fat fish category. Fish can be grouped into four categories according to their fat contents: lean fish (<2%), low fat (2-4%), medium fat (4-8%) and high fat (>8%) (Ackman, 1989). The deep-sea fish examined were found in all the categories except high fat. The species of lean fish were *Antigonia rubescens, Caelorinchus divergens, Polymixia sp, Setarches guentheri,* and *Xenolepidichthys dalgleishi*, while low fat deep-sea fish were Barbourisia rufa, Synagrops japonicus and Tydemania navigatoris. Only *Alepocephalus bicolor* fell in the medium fat category. The fat content in the species *Alepocephalus bicolor* was higher than reported previously by Ozagul and Ozagul (2007) but was lower than that reported by Guner et al. (1998). Lipid levels and fatty acid composition vary with species, sex, age, season of the year, food availability, salinity and water temperature (Stansby, 1981; Monsen, 1985).

Fatty acid profile of deep-sea fish muscles

The fatty acid composition of the species investigated is summarized in the Table 3. The results demonstrated that a significant part of the fatty acid in the muscles was saturated acid (SFA), monounsaturated fatty acid (MUFA) and polyunsaturated fatty acids (PUFA). The content of SFA varied from 0.85% to 49.19% of the total fat content among the different species examined, the range of MUFA content was between 4.31% and 50.09 % and PUFA varied from 1. 31% to 44.91%. Among the fatty acids, oleic acid (18:1) was dominant, especially in *Setarches guentheri* and Xenolepidichthys dalgleishi. On the

Table 2. Proximate composition and energy values of edible portion of the deep sea fish species (per 100 g)[a]

Fish Species	Water (%)	Ash (%)	Fat (%)	Protein (%)
Alepocephalus bicolor	74,50 ± 0,68	1,23 ± 0,03	4,84 ± 1,08	14,92 ± 0,20
Antigonia rubescens	74,27 ± 0,06	1,77 ± 0,30	0,02 ± 0,01	19,82 ± 1,16
Barbourisia rufa	82,58 ± 0,18	1,07 ± 0,02	2,87 ± 0,18	11,94 ± 0,41
Caelorinchus divergens	80,75 ± 1,26	1,03 ± 0,06	0,01 ± 0,01	18,14 ± 0,81
Polymixia sp	74,77 ± 0,09	1,32 ± 0,02	0,73 ± 0,08	20,81 ± 0,04
Rouleina guentheri	82,73 ± 0,12	1,41 ± 0,11	2,39 ± 0,65	12,75 ± 0,02
Setarches guentheri	78,35 ± 0,01	1,17 ± 0,01	0,02 ± 0,01	19,60 ± 0,64
Synagrops japonicus	73,29 ± 0,23	1,42 ± 0,05	1,35 ± 0,32	20,58 ± 0,07
Tydemania navigatoris	75,27 ± 0,75	2,48 ± 1,25	2,58 ± 0,36	18,34 ± 0,10
Xenolepidichthys dalgleishi	76,65 ± 0,82	1,39 ± 0,20	0,84 ± 0,10	19,55 ± 0,15

Table 3. Fatty Acid Composition of Some Deep-Sea Fish (% w/w)[b)]

Fatty acid (%)	*Alepocephalus bicolor*	*Antigonia rubescens*	*Barbourisia rufa*	*Caelorinchus divergens*
C8 : 0	0.00±0.00	0.05±0.00	0.24±0.01	0.68±0.00
C10 : 0	0.03±0.01	0.05±0.00	0.00±0.01	0.14±0.00
C12 : 0	0.02±0.02	4.87±0.00	2.84±0.01	0.96±0.00
C14 : 0	0.52±0.01	7.59±0.01	3.14±0.01	4.11±0.01
C16 : 0	0.66±0.01	25.54±0.03	21.60±0.06	35.06±0.00
C18 : 0	1.05±0.01	2.59±0.01	8.28±0.01	2.23±0.00
Σ SFA	**2.28**	**40.69**	**36.1**	**43.18**
C18 : 1	4.31±0.01	37.10±0.06	39.62±0.03	37.53±0.01
Σ MUFA	**4.31**	**37.1**	**39.62**	**37.53**
C18 : 2	2.34±0.01	1.31±0.02	0.00±0.02	0.00±0.01
C18 : 3	0.00±0.00	0.00±0.00	0.14±0.01	0.47±0.02
C20 : 5	1.22±0.01	1.15±0.01	4.61±0.03	1.40±0.03
C22: 6	0.81±0.01	0.39±0.01	3.44±0.01	2.03±0.01
Σ PUFA	**4.37**	**2.85**	**8.19**	**3.9**
PUFA/SFA	1.92	0.07	0.23	0.09
DHA/EPA	0.66	0.34	0.75	1.45
Unidentified	89.04	19.36	16.09	15.39

Table 3. Continue

	Polymixia sp	*Rouleina guentheri*	*Setarches guentheri*
C8 : 0	0.00±0.00	0.00±0.00	0.00±0.00
C 10 : 0	0.20±0.02	0.06±0.00	0.13±0.00
C 12 : 0	0.73±0.01	2.67±0.00	0.05±0.01
C 14 : 0	7.53±0.01	4.13±0.01	0.12±0.00
C 16 : 0	29.2±0.06	29.39±0.01	0.14±0.00
C 18 : 0	1.51±0.01	1.87±0.05	49.19±0.01
Σ SFA	**39.52**	**38.18**	**49.63**
C 18 : 1	0±0.0	44.01±0.03	0.29±0.01
Σ MUFA	**0**	**44.01**	**0.29**
C 18 : 2	44.91±0.01	0.00±0.00	0.00±0.01
C 18 : 3	0.17±0.01	0.25±0.01	0.04±0.01
C 20 : 5	0.95±0.01	1.14±0.01	0.99±0.51
C 22: 6	0.29±0.00	1.13±0.01	0.28±0.00
Σ PUFA	**46.32**	**2.52**	**1.31**
PUFA/SFA	1.17	0.07	0.03
DHA/EPA	0.3	0.99	0.28
Unidentified	14.16	15.29	48.77

Fatty acid (%)	*Synagrops japonicus*	*Tydemania navigatoris*	*Xenolepidichthys dalgleishi*
C8 : 0	0.02±0.00	0.00±0.00	0.00±0.00
C 10 : 0	0.00±0.01	0.00±0.00	0.18±0.10
C 12 : 0	0.32±0.01	2.18±0.01	3.12±0.10
C 14 : 0	0.08±0.01	4.17±0.00	1.53±0.0
C 16 : 0	0.02±0.00	21.12±0.03	31.49±0.03
C 18 : 0	0.42±0.01	3.09±0.05	1.94±0.01
Σ SFA	**0.86**	**30.56**	**38.26**
C 18 : 1	50.09±0.01	47.55±0.03	50.02±0.02
Σ MUFA	**50.09**	**47.55**	**50.02**
C 18 : 2	0.00±0.00	0.23±0.01	0.87±0.00
C 18 : 3	15.80±0.04	0.89±0.05	0.33±0.01
C 20 : 5	0.41±0	2.31±0.00	0.98±0.02
C 22: 6	0.40±0.01	1.22±0.01	0.43±0.01
Σ PUFA	**16.61**	**4.65**	**2.61**
PUFA/SFA	19.32	0.15	0.07
DHA/EPA	0.97	0.53	0.44
Unidentified	32.44	17.24	9.11

[b)] Two replicate GC analyses were performed and the results were expressed in GC area % as mean values ± standard deviation.

Table 4. The composition of oleic acid, EPA and DHA of selected species deep-sea fish and pelagic fish (mg/g fat)

Species	Oleic	EPA	DHA
Kembung (*Rastrelliger) kanagurta*)[a]	108.50	49.50	205.70
Tongkol (*Euthynnus affinis*)[a]	87.20	60.30	234.70
Kakap (*Lates calcarifer*)[a]	189.10	-	284.40
Alepocephalus bicolor	4.31	1.22	0.81
Antigonia rubescens	37.10	1.15	0.39
Barbourisia rufa	39.62	4.62	3.44
Caelorinchus divergens	37.53	1.40	2.03
Polymixia sp	0.00	0.95	0.29
Rouleina guentheri	44.01	1.14	1.13
Setarches guentheri	0.29	0.99	0.28
Synagrops japonicus	50.09	0.41	0.40
Tydemania navigatoris	47.55	2.31	1.22
Xenolepidichthys dalgleishi	50.02	0.98	0.43

a : values for pelagic fish (Kembung & Tongkol) and bottom fish (Kakap) are adopted

Table 5. Microelement content of edible portion of Deep Sea Fish species (mg 100 g $^{-1}$)[a]

Fish Spesies	Fe	I	Se	Zn	Cd	Hg	Pb
Alepocephalus bicolor	0,08±0.00	0,08±0.05	0,02±0.01	0,68±0.06	ND	ND	ND
Antigonia rubescens	0,04±0.01	0,15±0.01	0,04±0.03	0,68±0.08	ND	ND	ND
Barbourisia rufa	0,04±0.02	0,12±0.02	0,02±0.01	0,48±0.04	ND	ND	ND
Caelorinchus divergens	0,04±0.02	0,08±0.01	0,02±0.01	0,48±0.01	ND	ND	ND
Polymixia sp	0,04±0.01	0,16±0.05	0,02±0.04	0,58±0.04	ND	ND	ND
Rouleina guentheri	0,04±0.01	0,16±0.08	0,02±0.02	0,39±0.03	ND	ND	ND
Setarches guentheri	0,04±0.02	0,12±0.01	0,02±0.02	0,58±0.03	ND	ND	ND
Synagrops japonicus	0,08± 0.01	0,08±0.01	0,04±0.01	0,58±0.03	ND	ND	ND
Xenolepidichthys dalgleishi	0,08±0.01	0,08±0.02	0,02±0.01	0,48±0.02	ND	ND	ND
Thunnus	1,25±0.02	-	36,50±0.01	0,82±0.02	ND	ND	ND

[a] Values are mean (^SD) for triplicate analysis of a pooled sample
ND = Not detected

Table 6. Macroelement contents of edible portion of Deep Sea Fish species (mg 100 g $^{-1}$)[a]

Fish Spesies	Ca	K	Mg	P
Alepocephalus bicolor	32,83±0.04	72,22± 0.02	13,06±0.01	208,88±0.56
Antigonia rubescens	32,15± 0.02	71,27± 0.08	14,86 ± 0.03	206,4±0.29
Barbourisia rufa	31,13± 0.02	69,59± 0.01	15,80±0.01	254,31±0.68
Caelorinchus divergens	33,74±0.02	66,69±0.01	13,57±0.01	207,97±0.52
Polymixia sp	34,65±0.05	73,23±0.04	13,65±0.01	196,26±(0.05
Rouleina guentheri	40,02±0.01	78,20±0.01	16,79±0.01	230,82±0.02
Setarches guentheri	27,48±0.02	67,97±0.01	17,09±0.02	228,01±0.02
Synagrops japonicus	37,11± 0.01	64,52±0.01	14,92±0.02	200,28±0.04
Xenolepidichthys dalgleishi	28,43±0.01	69,52±0.02	13,43±0.03	224,54±0.01
Thunnus	29,00±0.01	407,0±0.01	34,00±0.10	222,00±0.01

[a] Values are mean (^SD) for triplicate analysis of a pooled sample

other hand, the content of PUFA from the species Polymixia sp and Setarches guentheri was 44.91% and 15.79% respectively. The ratio SFA/PUFA demonstrated a dominant percentage of saturated relative to polyunsaturated fatty acid, but the ratio [MUFA +PUFA]/SFA showed a dominant percentage of MUFA and PUFA relative to saturated fatty acid. The fatty acid composition of deep-sea fish examined were similar to that reported previously (Hayashi and Kishimura, 2003). Deep sea fish is composed mainly of monoenoic fatty acid, which is important for industrial use in food processing of hydrogenated fish oil, and are raw materials of margarine, fat spread or shortening. According to Okland et al. (2005) the deep-sea teleosts and elasmobranchs contain lipids that consisted mainly of polyunsaturated fatty acid (PUFA) and docosahexaenoic acid (DHA). In his studies on fatty acid profiles and fat contents of commercially important seawater and freshwater fish species Ozagul et al. (2007) showed that the proportion of n3 PUFAs of seawater fish were higher than that of fresh water. The concentration of ω3 PUFAs differs among species and can be influenced by a number of factors. The fatty acid composition of fish tissue can be affected by diet, size, age, reproductive cycle, salinity, temperature, season and geographical location (Lucia et al., 2003). The fatty acid composition of different fish from the same species can vary because of diet, location, gender and environmental conditions (Gruger, 1967). The demersal fish contained more MUFA than pelagic fish, while pelagic fish contained more PUFA than demersal fish (Kusumo, 1997). Some microalgae such as *Chlorella, Diatomae, Dinoflagellata, Euglena,* and *Nitszchia* closteriu could produce omega-3. Pelagic fish feeding on a phytoplankton having high omega-3 thus result in higher omega 3 content than demersal fish. A comparison of the composition of oleic acid, EPA and DHA of selected species deep-sea fish and pelagic fish is shown in Table 4.

The omega-9 fatty acids are effective in decreasing LDL cholesterol blood and also for increasing HDL cholesterol blood. They also have better capability for increasing HDL than omega-3 and omega-6nand also the capability to impede the production of eicosanoid structure (stimulants causing cancer in animal tests) (Pranoto, 2006).

A comparison of Tables 1 and 3 shows that the fatty acid composition and the depth of fish habitat has no correlation related to the profile of saturated fatty acid (SFA), monounsaturated acid (MUFA) and polyunsaturated acid (PUFA). These are more related to the food chain while deep sea fish moved vertical mobile at night for look far a feed for example plankton and phytoplankton. In generally they showed similar fatty acid composition with depth difference.

Microelement composition

The microelement contents of the edible portion of the deep sea fish species are listed in Table 5. Zn, Fe, I, Se, Cd, Hg and Pb, were determined by atomic absorption spectrophotometer in the raw tissues. Zn, an essential element for human metabolism (Burch, et al., 1975). It was present in the amount ranging from 0.39 mg/100 g in Rouleina guentheri to 0.68 mg/100 g in *Alepocephalus bicolor*. The Fe levels ranged from 0.04 mg/100 g in *Antigonia rubescens* to 0.08 mg/100 g in *Xenolepidichthys dalgleishi*. The Se levels were between 0.02 mg/100 g in Alepocephalus bicolor and 0.04 mg/100 g in *Synagrops japonicus*. The I levels were between 0.08 mg/100 g in *Alepocephalus bicolor* and 0.16 mg/100 g in *Polymixia* sp. The rest of the microelements, Cd, Hg, and Pb were all present in amounts below toxic levels (Mertz, 1987). When the amounts of these elements were compared with the suggested values, some deep sea fish can be considered as good sources of Zn and of Fe.

Macroelement composition

The macroelement contents of the edible portion of the deep sea fish species are listed in Table 6. Ca, K, Mg and P, were determined by atomic absorption spectrophotometer in the raw tissues. The Ca level ranged from 27.48 mg/100 g in *Setarches guentheri* to 40.02 mg/100 g in *Rouleina guentheri*. The K levels ranged from 64.52 mg/100 g in *Synagrops japonicus* to 78.20 mg/100 g in *Rouleina guentheri*. The Mg levels were between 13.06 mg/100 g in *Alepocephalus bicolor* and 17 and 09 mg/100 g in *Setarches guentheri*. The P levels were between 196 and 26 mg/100 g in *Polymixia* sp and 230 and 82 mg/100 g in *Rouleina guenther*.

Conclusion

The ten deep-sea fish species from Southern Java Ocean and Western Sumatra Ocean had a potential as source protein. The proximate analyses showed that protein content in seawater and fresh water fish were similar, but the deep-sea fish contained more fat. The fatty acid profile showed monounsaturated fatty acid (MUFA) composition higher than polyunsaturated acids (PUFA) and saturated (SFA) in most of the deep-sea fish studied, with a few exceptions. The level of microelements (Cd, Hg and Pb) were below toxic level

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