PHYSICOCHEMICAL CHARACTERISTICS OF AJI-AJI FISH *Seriola nigrofasciata* LIPIDS

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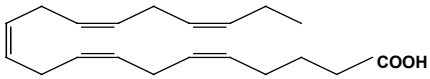
Abstract. The total lipids and fatty acid compositions in aji-aji fish, *Seriola nigrofasciata* was analysed. Fish oils were soxhlet extracted in a mixture of methanol:chloroform (1:2). The result showed that aji-aji fish content about 18.3% lipid (wt/wt). The lipid consists of high saturated fatty acids (SFA), 45.8±1.8% compared to monounsaturated fatty acids (MUFA) 32.4±0.5%), and polyunsaturated fatty acids (ω-6 PUFA; 1.0±0.2%) and ω-3 PUFA; 9.8±0.5%). Physicochemical properties of the lipid are characterized and showed comparatively with other tropical fish oils. Aji-aji fish oil extracted shows the acids value of 6.0±0.1, percentages of free fatty acid, FFA at 3.0±0.5%, iodine value (110.0±3.6), peroxides value (2.5±0.7), saponification value (259.5±2.0) and refractive index at the of 1.4670±0.1. Aji-aji fish oil shows relatively high in ω-3 PUFA content comparable with other local fish oils. The eicosapentaenoic acid, EPA and docosahexaenoic acid, DHA are the major PUFA content which are 1.1±0.1% and 8.0±1.0% respectively. However its ω-3 PUFA is quite low compared to commercial menhaden fish oil.

Abstrak. Penentuan kandungan lipid dan komposisi asid lemak dalam ikan aji-aji, *Seriola nigrofasciata* telah dilakukan. Minyak ikan diekstrak dengan menggunakan pelarut campuran methanol:kloroform (1:2) secara ekstraksi soxhlet. Keputusan menunjukkan ikan aji-aji mengandungi 18.3% lipid (bt/bt). Lipid ini mengandungi asid lemak tepu yang tinggi iaitu 45.8±1.8%, diikuti oleh asid lemak monotaktepu (MUFA; 32.4±0.5%) dan asid lemak politaktepu (ω-6 PUFA; 1.0±0.2% dan ω-3 PUFA; 9.8±0.5%). Sifat fisikokimia minyak ikan aji-aji telah ditentukan dimana ianya mempunyai sifat seperti minyak ikan topika lain secara relatif. Minyak ikan aji-aji mempunyai nilai keasidan sebanyak 6.0±0.1, peratusan asid lemak bebas, FFA 3.0±0.5, nilai iodin 110.0±3.6, nilai peroksida 2.5±0.7, nilai penyabunan 259.5±2.0 dan indeks bias 1.4670±0.1. Minyak ikan aji-aji mempunyai kandungan ω-3 PUFA yang tinggi berbanding ikan-ikan tempatan yang lain. Kandungan PUFAs yang utama dalam minyak ikan aji-aji adalah asid eikosapentaenoik, EPA dan asid dokosaheksaenoik acid, DHA dengan peratusan masing-masing 1.1±0.1% dan 8.0±1.0%. Walaubagaimanapun, kandungan ω-3 PUFAs dalam minyak ikan aji-aji adalah lebih rendah berbanding minyak ikan menhaden komersial.

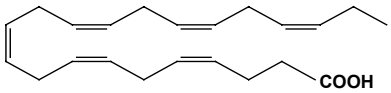
Keywords: Polyunsaturated fatty acid (PUFA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Introduction

Lipids and fatty acids are playing a significant role in membrane biochemistry and have direct effect on the membrane-mediated process in human such as osmoregulation, nutrient assimilation and transport [1]. The nature and quantity of fish lipids are vary according to the species and habitats. It is known that fish lipids are the main sources of polyunsaturated fatty acids (PUFAs) especially eicosapentaenoic acid (EPA; $C_{20:5}$) and docosahexaenoic acid (DHA; $C_{22:6}$) [2]. These two fatty acids cannot be synthesized by the human body and must be obtained from the diet [3]. These fatty acids structure are illustrated in the Figure 1. It has been reported that EPA and DHA have biochemical effect in prevention and treatment of several disorder and diseases such as coronary heart disease, rheumatoid arthritis, asthma, cancers, diabetes and others [4]. At present, the major sources of EPA and DHA are from the cool deep sea fish oil such as menhaden, cod, sardine, anchovy and others. Due to their biochemistry important, local fish's oil should be highlighted in order to discover their potential use. In this study a selected marine fish, Aji-aji was studied. The aim of this study is to determine the chemical composition of Aji-aji fish oil and its potential to be use or incorporation into human food, animal feed or other food products of higher value.



Eicosapentaenoic acid (EPA)



Docosahexaenoic acid (DHA)

Figure 1: Chemical structure for EPA and DHA.

Material and method

Materials

Aji-aji fish was obtained from the local wet market. The fish were gutted, washed and filleted. The sample was grinded and stored in the freezer and dried using freeze drier at -53°C for 3 days. Menhaden oil was bought from the local Sigma Co. All chemicals used were an analytical or high-performance liquid chromatography (HPLC) grades.

Lipid extraction

The fish lipid was extracted using a mixture of chloroform:methanol (2:1) by soxhlet extraction [5,6]. The lipid was then mixed with carbon active (10 % wt/wt), stirred and filtered. The solvents were dried using a rotor evaporatory. The crude extract was purified by adding an aqueous 0.88% KCl solution in the proportions (8:4:3) of chloroform:methanol:KCl [7]. The obtained lipid fraction was weighed and stored at -20 ^{o}C prior to analyses.

Fatty acid methyl ester

The fatty acids methyl ester (FAME) preparation was carried out to determine the fatty acids composition in lipid fraction. The extracted lipid (0.1 ml) was pipetted into the clean 10 ml of screw-top glass bottles, dissolved in 1 ml of hexane and converted to the methyl esters by reaction with 0.5 ml of sodium methoxide. The mixture was homogenized using the vortex for 10-15 seconds. The clear upper phase layer was pipetted out and injected to the gas chromatography, GC [8]. Menhaden oil was used as the standard of PUFA and the identity of individual FAME was compared after conversion to equavalent chain length. Routine GC analyses were performed on a Shimadzu GC-17A Gas Chromatography equipped with FID detector. The column used was BPX-70 (60m length x 0.32mm i.d x 0.25µm thickness), split ratio 100:1. The analyses were performed using programmed temperature at the initial temperature of 120 °C, with temperature increment rate at 3 °C/min and final temperature at 245 °C. The injection port temperature was set at 260 °C and detector temperature, was at 280 °C. Nitrogen gas was used as a carrier gas.

Physicochemical analysis

The extracted lipid was analysed for iodine value (IV), acids value (AV), percentages of free fatty acids (%FFA), peroxide value (PV), saponification value (SV) and refractive index (RI) according to PORIM Test Methods (1995).

Result and discussion

The Aji-aji, *Seriola nigrofasciata* is a demersal marine fish that lives at a depth of around 400m. The name of Aji-aji is known by local peoples, and it is also known as black-banded trivially or king fish. The fish can be obtained at local wet market, though it is an uncommon fish to consume. The percentages of crude and purified lipids of Aji-aji fish are shown in Table 1. It shows that Aji-aji fish contains about 18.3% of crude lipid and about 16.8% of lipid after purification process. The results showed that Aji-aji fish contains high in lipid content. Among local marine fishes studied, Aji-aji fish contain an average values in lipid percentage, ranging from 10 to 21% [2].

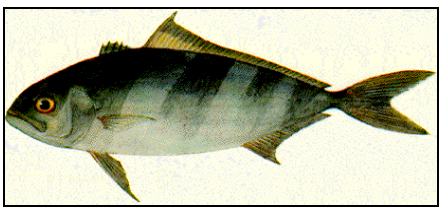


Figure 2 : Aji-aji fish

Table 1: Lipid content and percentages of Aji-aji fish oil.

Measurements	Crude lipid	Purified lipid
Total weigh (g)	24.1	22.1
Percentage (%)	18.3	16.8

Table 2 shows the fatty acids composition of Aji-aji fish oil. Three fatty acids particularly palmitic acid, stearic acid and oleic acid are the major fatty acids composition, which are 31.5±1.4%, 11.8±0.6% and 27.7±0.1% from the total fatty acids composition respectively. Saturated fatty acids, SFA represent dominant fatty acid type (45.8±1.8%), whereas monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) exist in less amount, about 32.4±0.5% and 10.8±0.5% respectively. PUFA in omega-3 class exhibits higher percentage than PUFA in omega-6 class. DHA (8.0±1.2) contain in Aji-aji fish oil is higher than EPA (1.1±0.1) comparatively. However their percentages are much lower compared to EPA (13.8±0.1%) and DHA (12.6±0.4%) contain in Manhaden fish oil (cold water fish). Lipid content and fatty acid composition of marine fishes are differ among species, sex, age, size, reproductive status, geographic location and season [9]. Fish oil is a major source of PUFA, mainly EPA and DHA where they are important for human health and nutrition, as well as for fish it self. The role of PUFA in fish is to maintain the cellular structure and its function, and also to regulate the cell normal growth and development [10]. Under the normal circumstances, fish gains the PUFA from it diet mainly from the phytoplankton.

Table 2: Fatty acid composition of Aji-aji fish oil.

Fatty acids	Percentage (%)	
	Menhaden oil	Aji-aji oil
Miristic; $C_{14:0}$	8.8±0.5	2.5±0.1
Palmitic; $C_{16:0}$	19.5±0.5	31.5±1.4
Palmitoleic; $C_{16:1\ \omega7}$	11.3±0.3	4.7±0.7
Stearic; $C_{18:0}$	3.3±0.2	11.8±0.6
Oleic; $C_{18:1\ \omega\ 9c}$	7.9±0.1	27.7±0.1
Linoleic; $C_{18:2\ \omega6}$	1.4±0.1	1.0±0.2
Stearidonic (SA); $C_{18:4\ \omega3}$	2.7±0.2	0.8±0.5
EPA; $C_{20:5\ \omega3}$	13.8±0.1	1.1±0.1
DHA; $C_{22:6\ \omega3}$	12.6±0.4	8.0±1.2
Others	18.7±0.6	11.0±1.8
ΣSFA[a]	31.6±0.9	45.8±1.8
ΣMUFA[b]	19.2±0.2	32.4±0.5
ΣPUFA[c]	30.5±0.4	10.8±0.5
ΣPUFA-$_{\omega3}$	29.1±0.4	9.8±0.5
ΣPUFA-$_{\omega6}$	1.4±0.1	1.0±0.2

a =C14:0 + C16:0 + C18:0; b =C14:1 + C16:1 + C18:1n7c +C18:1n9c; c =C18:2 + C18:4 + C20:5 + C22:6

The physicochemical properties of Aji-aji fish oil are shown in Table 3. The oil showed high in iodine value at 110.0±3.6, acid value (6.0±0.1), free fatty acids (3.0±0.1), peroxide value (2.5±0.7) and refractive index (1.4670±0.1). On the other hand, Menhaden fish oil shows higher iodine value of 188.3±2.8 and less in acid value 1.0±0.1, free fatty acids (0.5±0.3), peroxide value (1.5±0.1) and refractive index (1.4826±0.1) respectively. Higher the iodine value in Manhaden oil is due to higher percentage of fatty acids containing more numbers of double bonds in their chain length, compared to Aji-aji fish oil. This is clearly shown by higher percentage of PUFA in Manhaden fish oil (30.5±0.4) compared to Aji-aji fish oil (10.8±0.5). Higher values in Aji-aji fish oil for acid value, FFA and peroxide value are due to impurities that are not completely removed through the mixing and filtration processes with carbon active. On the other hand, Manhaden oil used are commercial sample with higher in purity. The saponification value of Aji-aji fish oil is higher than Menhaden oil which are 259.5±2.0 and 180.9±2.0 respectively. This value indicates that Aji-aji fish oil contains shorter fatty acid chain length with lower molecular weight compared to Manhaden oil. This is particularly true due to high contain of long chain PUFA, EPA and DHA. The higher the saponification value, the lower the average molecular weight [11].

Table 3: Physicochemical properties of Aji-aji fish oil.

Parameters	Menhaden oil	Aji-aji oil
Iodine value	188.3±2.8	110.0±3.6
Acid value	1.0±0.1	6.0±0.1
%free fatty acids	0.5±0.3	3.0±0.1
Peroxide value	1.5±0.1	2.5±0.7
Refractive index	1.4826±0.1	1.4670±0.1
Saponification value	180.9±2.0	259.5±2.0

Conclusion

Aji-aji fish oil contains relatively high in monounsaturated fatty acids and an average in polyunsaturated fatty acid especially EPA and DHA. The ratio of saturated to unsaturated fatty acids remains nearly 50:50. However it is plausible to say that Aji-aji fish oil has the potential to be used as a local source of PUFA due to its comparatively high content of EPA and DHA.

Acknowledgements

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