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Article

The Potential of *Pomadasys argyreus* (Popondok Fish) Oil as an Omega-3 Source from the Mangrove Ecosystems of Southeast Sulawesi

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Abstract

One of the marine products with high nutritional value is the popondok fish (*Pomadasys argyreus*). This species is commonly found in the mangrove ecosystems of Sulawesi and is utilized as an accessible source of animal protein for coastal communities. This study aims to analyze the fatty acid composition and physicochemical characteristics of popondok fish oil (*Pomadasys argyreus*). The popondok fish samples were obtained from Lembo Village, North Konawe Regency, Southeast Sulawesi Province. The fish oil was extracted using the Soxhlet extraction method at 70°C with *n*-hexane as the solvent and purified by using bentonite. The purified fish oil was then characterized for its physicochemical properties, including acid value, peroxide value, iodine value, and saponification value, and its fatty acid composition was analyzed using GC-FID. The measured acid (0.4±0.01) and peroxide (4.30±0.02) values of the popondok fish oil indicated good quality, while the iodine value (66.40±1.04) met the national standard. The saponification value (114.64±0.23) suggested that the fatty acids in the oil were predominantly medium- to long-chain. The fatty acid profile revealed 41.86% saturated fatty acids, 26.54% monounsaturated fatty acids, and 31.60% polyunsaturated fatty acids, with palmitic acid, oleic acid, and docosahexaenoic acid (DHA) as the dominant components. The oil also exhibited a favorable PUFA/SFA ratio (0.75), a high n-3/n-6 ratio (5.06), and substantial omega-3 content (EPA + DHA = 23.10%). In addition, low atherogenic (0.68) and thrombogenic (0.39) indices indicate potential cardioprotective effects. Overall, popondok fish oil demonstrates a balanced composition between nutritional quality and oxidative stability, highlighting its potential as a promising local source for functional food and pharmaceutical applications.

Keywords: *Fatty acids; fish oil, Omega-3, Popondok fish*

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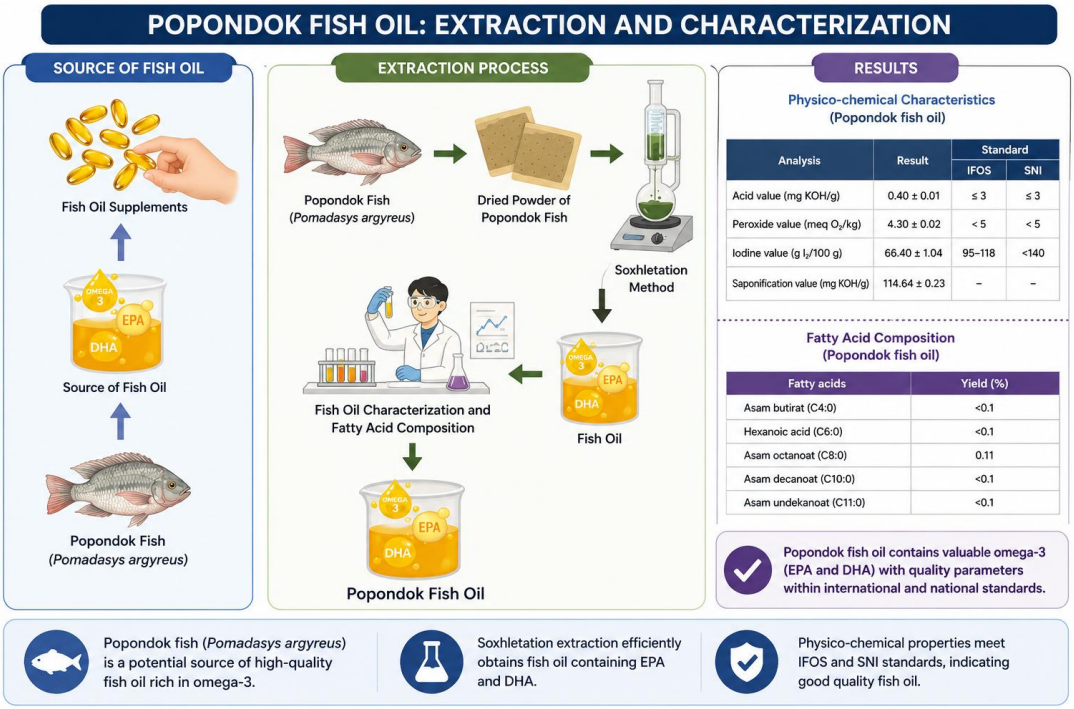
Graphical Abstract



Introduction

Indonesia, a maritime country with an abundant potential for marine commodities. Indonesia's marine wealth is not only an economic source, but also contributes as a source of nutritious food for the community. One of the marine commodities that has high nutrients is popondok fish (*Pomadasys argyreus*). This fish is widely found in the Sulawesi mangrove ecosystem, which is used as a source of animal protein that is easily accessible to coastal communities [1–3].

Pomadasys argyreus is one of marine commodity that contains omega-3 essential fatty acids. Omega-3 fatty acids consist of several main types, namely eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and alpha-linolenic acid (ALA) [4,5]. DHA and EPA are widely found in marine fish and have important benefits in cardiovascular function [6], brain development [7], as well as anti-inflammatory agents [8]. Meanwhile, ALA generally comes from plant-based commodities such as flaxseeds and walnuts. Some studies show that omega-3 consumed regularly can lower the risk of heart disease [9], help brain development for children [10] and improve lipid profiles [11].

Various types of marine commodities such as salmon, tuna, sardines, mackerel, and including popondok fish are known to contain omega-3 fatty acids in varying levels and qualities [8,12]. Research shows that fish with the genus *pomadasys* from Indonesia's tropical waters contains EPA and DHA, although the levels not as high as fish from cold waters such as salmon [4,13]. EPA and DHA are omega-3 components of fish oil. The quality of fish oil can be seen through physico-chemical characterizations such as acid value, peroxide value, iodine value and saponification value [14–16]. However, the consumption of popondok fish can still make a significant contribution to daily omega-3 intake, especially for people living in the coastal areas of Southeast Sulawesi. The researcher hopes that the results of this

study can be a benchmark for the quality of popondok fish oil in the coastal area of Southeast Sulawesi. So that popondok fish is not only a source of food for the community but can be used as a source of raw materials for quality fish oil supplements.

Materials and Methods

Materials

The main sample of this study is Popondok Fish Meat (*Pomadasys argyreus*) obtained from Lembo village, North Konawe Regency, Southeast Sulawesi Province, Indonesia. The manufacture, refining and characterization of fish oil is carried out at the Research Laboratory of the Faculty of Pharmacy, Halu Oleo University, Kendari, Southeast Sulawesi. The chemicals used in this study are *n*-hexane (Merck®), ethanol (Merck®), methanol (Merck®), chloroform (Merck®), distilled water (PT. Jayamas Medica Industri, Indonesia®), Wijs reagent, KOH 0.1 N, HCl, KI 15%, $Na_2S_2O_3$, KIO_3, Na_2SO_4 0.1 N, oxalic acid 0.1 M, Amylum 1% indicator, phenolphthalein (PP) indicator, NaOH, BF_3, NaCl. All chemicals used in the preparation and analysis process are grade analysis. The equipment in this study is an oven (Stuart Scientific®), a series of Soxhlet tools (Pyrex®), rotary vacuum evaporator (rotavapor) (Stuart®), analytical scales (Fujitsu®), centrifuges (Boeco Germany®), blenders (Phillips), 25 and 50 mL burettes (Pyrex®), GC-FID Agilent 7890B, hot plates (Stuart®) and glass tools that are often used in analytical laboratories.

Extraction and Purification

Popondok fish oil was extracted using the Soxhlet extraction method at 70°C with n-hexane as the solvent. Briefly, 50 g of dried fish sample was extracted with 750 mL of n-hexane for 2 h. After extraction, the mixture was cooled to room temperature, and the solvent was removed using a rotary evaporator at 50°C. The obtained fish oil was weighed and stored in a sealed container at 4°C until further analysis [17,18].

The crude fish oil was subsequently purified in two stages. First, anhydrous Na_2SO_4 was added to remove residual moisture. Second, bentonite (1% w/w of oil) was added to reduce impurities and free fatty acids. The mixture was then centrifuged at 25,000 rpm for 10 min to separate the purified oil from solid residues. The purified fish oil was further characterized for its physicochemical properties, including acid value, peroxide value, iodine value, and saponification value according to AOAC (2016) methods. In addition, the fatty acid composition was analyzed using GC-FID.

Acid value determination

A total of 5 g of fish oil sample was placed in an Erlenmeyer flask, followed by the addition of 50 mL of neutralized ethanol. The mixture was shaken thoroughly to ensure complete homogenization. Subsequently, 2 mL of phenolphthalein indicator was added, and the solution was titrated with 0.1 N potassium hydroxide (KOH) until a stable pale pink color persisted for approximately 30 s.

Peroxide value determination

A total of 5 g of fish oil sample was placed in an Erlenmeyer flask and mixed with an acetic acid–chloroform solution (3:2, v/v), followed by thorough homogenization. Subsequently, 0.5 mL of potassium iodide solution was added, and the mixture was allowed to stand for 1 min in the dark before being homogenized again. Afterward, 30 mL of distilled water was added to the mixture. The liberated iodine was titrated with 0.1 N sodium thiosulfate ($Na_2S_2O_3$) solution until the color changed to pale yellow. Then, 1 mL of 0.5% amylum indicator was added, and the titration was continued until the blue

color completely disappeared, indicating the endpoint of the reaction.

Iodine value determination

0.5 g of fish oil sample was placed in a tightly closed Erlenmeyer flask, followed by the addition of 15 mL of trichloromethane and 25 mL of Wijs reagent. The mixture was incubated in the dark for 30 min with occasional shaking. Subsequently, 20 mL of potassium iodide solution and 100 mL of distilled water were added. The liberated iodine was titrated with 0.1 N sodium thiosulfate ($Na_2S_2O_3$) solution until the yellow color became faint. Then, 1 mL of 1% amylum indicator was added, and the titration was continued until the blue color completely disappeared, indicating the endpoint of the reaction.

Saponification value determination

5 g of fish oil sample was placed in an Erlenmeyer flask, followed by the addition of 50 mL of ethanolic potassium hydroxide (KOH) solution. The flask was connected to a reflux condenser and heated under reflux for 30 min. After cooling to room temperature, the solution was titrated with 0.5 N hydrochloric acid (HCl) using phenolphthalein as an indicator until the pink color disappeared, indicating the endpoint of the titration.

Fatty acid analysis

The fatty acid composition of the fish oil was analyzed using Gas Chromatography–Flame Ionization Detection (GC-FID) following derivatization into fatty acid methyl esters (FAMEs). Briefly, 0.5 mL of fish oil sample was placed in a sealed reaction tube and mixed with 1.5 mL of sodium methoxide in methanol. The mixture was heated at 60°C for 5–10 min with intermittent shaking. After cooling to room temperature, 2 mL of boron trifluoride (BF_3) reagent was added, and the mixture was reheated under the same conditions to complete the methylation process. Subsequently, the solution was cooled and extracted with 1 mL of heptane and 1 mL of saturated sodium chloride solution. The upper organic layer containing FAMEs was collected and transferred into a GC vial for analysis.

Fatty acid composition was determined using a GC-FID system (Agilent Technologies 7890B, USA). The injector conditions were as follows: injection volume of 1 µL, injector temperature of 260°C, pressure of 80 psi, total flow rate of 22 mL/min, split ratio of 10:1, and septum purge flow of 18 mL/min. The detector temperature was maintained at 260°C using helium as the carrier gas and nitrogen as the makeup gas, with a makeup gas flow rate of 30 mL/min, hydrogen flow rate of 40 mL/min, and air flow rate of 400 mL/min. Separation was performed using an HP-88 capillary column (100 m × 0.25 mm i.d., 0.20 µm film thickness). The oven temperature program was initiated at 100°C and held for 5 min, followed by an increase at a rate of 4°C/min to 240°C and held for 15 min, resulting in a total run time of 55 min

Result and Discussion

Extraction and Purification

Popondok fish (*Pomadasys argyreus*) used comes from the sea of Lembo village, North Konawe regency, Southeast Sulawesi. The fish oil extraction process is carried out by the soxhletation method. A total of 50 g of popondok fish powder was extracted with 750 mL of *n*-hexane for 2 h, resulting in an extraction yield of 9%, which is within the typical range reported for fish oil extraction from tropical marine species. Previous studies have reported yields of approximately 5–12% for fish oils derived from species such as catfish (*Clarias gariepinus*) and tilapia (*Oreochromis niloticus*),

depending on extraction conditions and raw material characteristics. This yield indicates a relatively efficient extraction process, considering that Soxhlet extraction with non-polar solvents such as n-hexane is known to provide high lipid recovery. The extraction temperature and duration can influence the physicochemical properties and fatty acid composition of the oil. Higher temperatures and prolonged extraction times may increase extraction yield but can also promote lipid oxidation and degradation of polyunsaturated fatty acids. Therefore, controlled extraction conditions are necessary to maintain the quality of the extracted oil. Crude fish oil extracted usually still contains contaminants. The purification of extracted fish oil is carried out by adding Na_2SO_4 to remove water content and add bentonite adsorbents that can absorb contaminants [15,19]. In addition, the solvent was removed by evaporation to ensure that no residual *n*-hexane remained in the final oil product. This is aimed at improving its characteristics and quality which will have an impact on its shelf life [20]. Popondok fish oil (*Pomadasys argyreus*) which is obtained has a special aroma of fish oil which is not too fishy and pungent. The aroma of popondok fish oil obtained indicates that fish oil has not undergone the formation of volatile compounds such as aldehydes or ketones. If the volatile compounds resulting from oxidation have formed, the resulting fish oil will have a rancid aroma [21]. Visually, the color of popondok fish oil before and after purification is presented in figure 1. The color difference between the two is quite obvious. According to Putri, et al., (2020) the color of the extracted fish oil is influenced by several things such as the extraction method, temperature and pressure at the time of extraction, as well as natural dyes contain in fish such as carotene, xanthophyll, and anthocyanins [23]. The clear result of fish oil indicates the sumlessful purification of fish oil or it can be said that fish oil is sumlessfully separated from dirt, water, and denatured proteins [15].

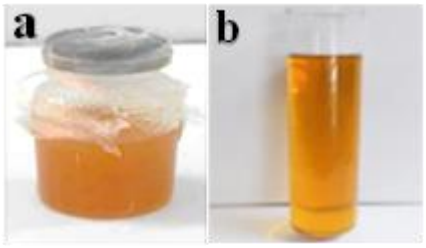


Figure 1. Popondok fish extraction (a). the results of extraction; (b). the purified of popondik fish oil *(Pomadasys argyreus).*

Physico-chemical characteristics

The quality of the popondok fish oil produced was then analyzed for its physico-chemical characteristics. Fish oil analysis is performed by measuring the acids, peroxides, iodine, and saponification value. The results of the analysis of the characteristics of popondok fish oil are presented in table 1. Based on the results of the analysis of popondok fish oil (*Pomadasys argyreus*) the number of acids obtained is 0.40 mg KOH/g. These results have met IFOS standards (International Fish Oil Standard) and SNI (Indonesian National Standard). The acids value in fish oil reflects the amount of free fatty acids it has. The acids value comes from the hydrolysis process of triacylglycerol. The acids value is inversely proportional to the quality of the fish oil produced. The high acid count of fish oil reflects the deteriorating quality of the fish oil produced, as it shows degradation due to the activity of the natural lipase enzyme [15,16]. The acid value of popondok fish oil indicates that the oil remains suitable for food applications and as a raw material for supplements, as lipid degradation is minimal.

The number of peroxides is an indicator that is also used to measure the quality of fish oil. This value describes the degree of oxidation or damage that occurs in fish oil. Based on the results of the measurement of the peroxides value of popondok fish obtained is still in accordance with the standard, which is 4.30 mEq O_2/kg. The peroxide value can increase as a result of fish oil exposure by oxygen or light. Popondok fish oil tends to have high oxidative stability. This is suspected to be due to the high concentration of polyunsaturated fatty acids in popondok fish oil balanced by natural antioxidant compounds such as tocopherol and carotenoid pigments from fish tissue. These antioxidant compounds can protect fish oil from oxidation reactions. These results illustrate that the fish oil produced in this study is still of high quality [24].

Table 1. Physico-chemical characteristics of popondok fish oil (*Pomadasys argyreus*)

Analysis	Result*	Standard	
		IFOS	SNI
Acid value	0.40 ± 0.01	≤ 3	≤ 3
Peroxide value	4.30 ± 0.02	<5	<5
Iodine value	66.40 ± 1.04	95-118	<140g
Saponification value	114.64 ± 0.23	-	-

*Values are expressed as mean ± SD (n = 3)

Fatty acid analysis

In addition, the resulting popondok fish oil was analyzed for its fatty acid composition by Gas-Chromatography Flame Ionization Detector (GC-FID). The results of the analysis of the fatty acid composition of popondok fish oil are presented in table 2. Based on the results of the analysis of the composition of fatty acids, popondok fish oil contains saturated fatty acid (41.86%), monounsaturated fatty acid (26.54%) and polyunsaturated fatty acid (31.60%). The PUFA/SFA ratio was calculated is 0.75, this value indicates a moderate proportion of polyunsaturated fatty acids relative to saturated fatty acids. This value exceeds the recommended threshold of 0.4, suggesting favorable nutritional properties and potential cardiovascular benefits. Furthermore, the n-3/n-6 ratio was found to be 5.06, indicating a predominance of omega-3 fatty acids over omega-6, which is associated with anti-inflammatory effects and a reduced risk of chronic diseases [27,28].

The total omega-3 content, calculated as the sum of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), was 23.10% (EPA 3.05% and DHA 20.05%). This relatively high omega-3 content, particularly the dominance of DHA, highlights the nutritional value of popondok fish oil. DHA plays a critical role in brain development [10] and neuronal function [7], while EPA is known for its anti-inflammatory [8] properties and its role in cardiovascular protection [6]. Therefore, the substantial EPA and DHA content suggests that popondok fish oil may serve as a valuable source of functional lipids with significant health benefits

In addition, the atherogenic index (AI) and thrombogenic index (TI) were calculated as 0.68 and 0.39, respectively. These relatively low values indicate a reduced potential for atherosclerosis and thrombosis, reflecting a favorable balance between pro-atherogenic

saturated fatty acids and protective unsaturated fatty acids. Collectively, these lipid quality indices demonstrate that popondok fish oil possesses a cardioprotective profile and good nutritional quality [27,29].

The dominant fatty acids identified were palmitic acid (27.95%), cis-9-oleate acid (13.58%), and cis-4,7,10,13,16,19-dokosahexaenoate-DHA (20.05%) which are the main components of high-quality fish oil. From a biological and functional perspective, these fatty acids play important roles in human health. Palmitic acid, as a major saturated fatty acid, serves as an essential energy source and contributes to membrane structure. However, excessive intake has been associated with increased cardiovascular risk [30]. In contrast, oleic acid, a monounsaturated fatty acid, is known for its beneficial effects on lipid metabolism, including reducing low-density lipoprotein (LDL) cholesterol and improving overall cardiovascular health. DHA is a long-chain omega-3 polyunsaturated fatty acid, is particularly important due to its critical role in brain development, cognitive function, and anti-inflammatory activity [31]. These results are similar to the research of Bakan et al, (2020) which indicates that the fatty acid composition of fish oil *Pomadasys Battle* Treasuries is palmitic acid, acea oleic acid and docosahexanoic acid [4]. This comparison of fatty acid composition illustrates that popondok fish oil has characteristics comparable to other tropical marine fish oils, such as tuna and catfish, but with a slightly lower composition of saturated fatty acids [12,23,32].

Table 2. Fatty acids composition of popondok fish oil (*Pomadasys argyreus*)

Fatty acids	Yield (%)
Asam butirat (C4:0)	<0.1
Hexanoic acid (C6:0)	<0.1
Asam Octanoat (C8:0)	0,11
Asam dekanoat (C10:0)	<0.1
Asam undekanoat (C11:0)	<0.1
Asam laurat (S12:0)	<0.1
Asam tridekanoat (C13:0)	<0.1
Myristic acid (C14:10)	2.91
Asam pentadecanoate (C15:0)	1.15
Asam palmitat (C16:0)	27.95
Asam heptadekanoat (C17:0)	2.47
Asam stearate (C18:0)	4.71
Asam arakidat (C20:0)	0.23
Asam heneikosanoat (C21:0)	0.46
Doxoanoic acid (C22:0)	0.34
Trichosanoic acid (C23:0)	0.12
Asam lignosated (C24:0)	1.40
ΣSFA	41.86
Asam miristoleat methyl ester (S14:1)	0.12
Asam cis-10-pentadekeanoate (C15:0)	0.13

Fatty acids	Yield (%)
Asam palmitolar (C16:1)	0.87
Asam cis-10-heptadekenoate (C17:1)	0.69
Trans-9-elacite acid (C18:1)	9.1
Asam cis-9-oleate (C18:1)	13.58
Asam cis-11-eikosanoat (C20:1)	0.15
Erucic acid (C12:1n9)	0.3
Asam nervonat (C24:1)	1.6
ΣMUFA	26.54
Linolelicic acid (C18:2n9t)	2.42
Asam linoleat (C18:2n6c)	1.52
Asam gamma-linolenat (C18:3n6)	0.44
Asam linolenat (S18:3)	0.52
Cis-11,14-eicosadienoic acid (C20:2)	0.13
Asam cis-8,11,14-eikosatrienoat (C20:3n6)	0.28
Asam cis-11,14,17-eikosatrienoat (C20:2)	0.24
Asam cis-5,8,11,14-eikosatetraenoat (C20:3n6)	2.43
Cis-13,16-docosadienoic acid (C22:6)	0.52
Asam cis-5,8,11,14,17-eikosapentaenoate-EPA (C20:5n6)	3.05
Cis-4,7,10,13,16,19-docosaexaenoate-DHA acid (C22:6n3)	20.05
ΣPUFA	**31.60**

This may be related to the habitat of popondok fish in mangrove ecosystems, where variations in natural feed affect the lipid composition of the fish's body. The fatty acid composition of fish oil can be influenced by several ecological factors, including the diet of the fish, seasonal variations, and environmental conditions. Popondok fish inhabits mangrove ecosystems, where the availability of natural food sources such as plankton, small crustaceans, and detritus may influence the accumulation of specific fatty acids, including EPA and DHA. In addition, environmental factors such as water quality and potential exposure to pollutants may also affect lipid composition. Mangrove areas can act as sinks for environmental contaminants, and substances such as heavy metals (e.g., Hg and Pb), polychlorinated biphenyls (PCBs), and dioxins may accumulate in aquatic organisms through bioaccumulation processes. Therefore, variations in fatty acid profiles and overall oil composition may partly reflect ecological conditions in the mangrove habitat where the fish are found.

The physicochemical parameters of popondok fish oil are closely associated with its fatty acid composition and provide important insights into its quality, stability, and nutritional value. The low acid value (0.40 mg KOH/g) indicates minimal hydrolysis of triglycerides, which is consistent with the relatively high proportion of intact fatty acids, particularly unsaturated fatty acids (58.14%). This suggests that lipid degradation into free fatty acids was limited, preserving the integrity of bioactive components such as EPA and DHA. Recent

studies have reported that low acid values are indicative of good-quality fish oil with minimal hydrolytic degradation and better preservation of functional lipids [33].

The peroxide value (4.30 mEq O_2/kg), which reflects the presence of primary oxidation products, remains within acceptable limits, indicating good oxidative stability despite the relatively high PUFA content (31.60%). This finding is important because polyunsaturated fatty acids are highly susceptible to oxidative degradation. Lipid oxidation typically begins with the formation of primary compounds such as hydroperoxides and peroxides, which are unstable and rapidly decompose into secondary volatile oxidation products. These secondary compounds including aldehydes, ketones, hydrocarbons, alcohols, and esters are responsible for the deterioration of oil quality, particularly through the development of undesirable off flavors known as oxidative rancidity. Nevertheless, the relatively low peroxide value observed suggests that oxidation has been effectively controlled, likely due to appropriate processing conditions and the presence of natural antioxidants that help inhibit lipid peroxidation [34,35].

The iodine value (66.40 g I_2/100 g oil) further supports the fatty acid profile, as it reflects the degree of unsaturation within the oil. This value is consistent with the moderate PUFA/SFA ratio (0.75) and indicates a balanced level of unsaturation. Recent literature suggests that moderate iodine values are associated with improved oxidative stability while still maintaining beneficial unsaturated fatty acid content [36,37].

In addition, the saponification value (114.64 mg KOH/g) provides insight into the average molecular weight and chain length of the fatty acids present. The observed value suggests the predominance of medium to long chain fatty acids, which aligns with the GC-FID results showing high levels of palmitic acid (C16:1), oleic acid (C18:1), and long chain omega-3 fatty acids such as DHA (C22:6). Recent studies confirm that marine fish oils rich in long-chain fatty acids, particularly EPA and DHA, exhibit significant biological activities, including cardioprotective, anti-inflammatory, and neuroprotective effects [38,39].

The fatty acid composition and physicochemical characteristics of popondok fish oil demonstrate several similarities, as well as notable distinctions, when compared with other fish oils reported in recent literature. In general, marine fish oils such as tuna, sardine, and catfish are characterized by high levels of unsaturated fatty acids, particularly PUFA, with reported PUFA contents typically ranging from 25% to 40% depending on species and environmental conditions [12,14]. The PUFA content of popondok fish oil (31.60%) falls within this range, indicating comparable nutritional quality. However, the n-3/n-6 ratio (5.06) observed in this study is relatively higher than that reported for many commercially available fish oils, which often exhibit ratios between 1 and 4 [27]. This suggests a more favorable anti-inflammatory profile and greater potential for cardiovascular health benefits. Furthermore, the total omega-3 content (EPA + DHA = 23.10%) is considered substantial for a tropical marine species, although slightly lower than cold-water fish such as salmon, which are known to contain higher omega-3 levels [12]. Notably, the dominance of DHA (20.05%) over EPA (3.05%) represents a unique characteristic, as many fish oils typically show a more balanced EPA/DHA ratio. This high DHA proportion may provide enhanced benefits for brain development and cognitive function. In terms of lipid quality indices, the relatively low atherogenic

index (0.68) and thrombogenic index (0.39) indicate a favorable lipid profile, comparable or even superior to several reported marine fish oils [29]. Additionally, the physicochemical parameters, particularly the low acid value and acceptable peroxide value, suggest better oxidative stability compared to some fish oils that are more prone to rapid oxidation due to higher unsaturation levels [36,37]. This balance between moderate unsaturation (iodine value 66.40 g I_2/100 g) and oxidative stability represents an important advantage, as it may contribute to longer shelf life without significantly compromising nutritional value.

Overall, the results indicate that popondok fish oil possesses good quality and oxidative stability, along with a high content of essential fatty acids. Compared to other fish oils reported in the literature, it exhibits a distinctive combination of moderate PUFA content, a high n-3/n-6 ratio, DHA predominance, and favorable lipid quality indices, which collectively contribute to its strong nutritional and functional value. This balance between unsaturation and stability provides both health benefits and technological advantages, particularly for applications requiring improved shelf life without compromising bioactivity. Therefore, popondok fish oil shows significant potential to be developed as a locally sourced raw material for functional foods and pharmaceutical products. In addition, its utilization may enhance the economic value of local fishery resources while supporting the sustainability and independence of fish oil production in Indonesia.

Conclusions

Popondok fish (*Pomadasys argyreus*) oil exhibits good physicochemical quality, balanced fatty acid composition, and promising nutritional value. The extraction yield (9%) indicates efficient recovery, while low acid and peroxide values reflect good stability. The oil is characterized by a moderate PUFA/SFA ratio (0.75), a high n-3/n-6 ratio (5.06), and substantial omega-3 content (EPA + DHA = 23.10%), with DHA as the dominant fatty acid. Additionally, low atherogenic (0.68) and thrombogenic (0.39) indices suggest potential cardioprotective benefits. Overall, the oil demonstrates a favorable balance between nutritional quality and oxidative stability, making it a promising local source for functional food and pharmaceutical applications.

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Author Contributions

Conceptualization, Irnawati, Nita Trinovitasari, and Nurull Hikmah; Methodology, Nurul Aliah Fadhillah and Irnawati; Software, Nita Trinovitasari; Validation, Irnawati, Nurull Hikmah and Nita Trinovitasari; Formal Analysis, Irnawati; Investigation, Nurul Aliah Fadhillah; Resources, Irnawati and Nurul Aliah Fadhillah; Data Curation, Irnawati; Writing – Original Draft Preparation, Nurul Aliah Fadhillah; Nurull Hikmah; Writing – Review & Editing, Nita Trinovitasari, and Irnawati; Visualization, Nita Trinovitasari; Supervision, Irnawati; Project Administration, Irnawati; Funding Acquisition, Irnawati.

Conflict of Interest

The authors declare no conflict of interest.

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