

Characteristics of Fish Protein Concentrate (FPC) of SeaWater Fish

ABSTRACT

The purpose of this article review is to study the types of sea fish that can be processed into FPCs, FPC creation methods, and FPC characteristics of sea fish from various research results in Indonesia. Based on the results of various articles and other literature obtained the conclusion that the types of sea fish that can be processed into FPCs are tuna, mackerel, anchovies, snapper, and Sunglir. FPC creation method can be done by reduction, way of "wholemeal", dry reduction methods, and extraction methods with solvents extraction. Karakarakterik FPC obtained from various research conducted is highly dependent on the type of fish and the method of making FPCs used.

Keywords: Reduction, solvent, tuna fish, FPC.

1. INTRODUCTION

Indonesia is the largest island nation with a total of 17,504 islands from Sabang to Merauke surrounded by the ocean, it is not surprising that Indonesia's sea area is 75% of the land consisting of 3.25 million km² territorial sea and 2.55 million km² is an Exclusive Economic Zone, and has the second-longest coastline after Canada with a length of 104 thousand km (KKP 2020). With the vastness of existing marine areas, Indonesia's natural resources, especially in the sea and coast should have great potential, it is estimated that the potential of fishing and aquaculture resources reaches US\$ 15.1 billion per year and US\$ 46.7 billion per year (KKP 2011 in Pursetyo et al. 2015).

Production of sea fish fisheries sold in TPI in the period 2017-2019 increased, can be seen in 2017 reached 657,691 tons, in 2018 reached 807,788 tons, and in 2019 reached 816,945 tons. The main commodity of sea fishing in the period 2017, namely cakalang reached 467,548 tons, cob reached 471,009 tons, tuna reached 293,333 tons, shrimp reached 400,073, and others reached 4,792,251 tons with a production value of 10.56 billion rupiahs,

cobs of 10.32 billion rupiah, shrimp of 10.59 billion rupiahs, and others of 22 billion rupiahs (Central Bureau of Statistics (2020).

Export activities in 2020 reached US\$ 2.407 billion with a production volume of 596,165,081 kg. Major commodities such as shrimp reached US\$ 466.24 million (37.56%), tuna-cob-cakalang (TTC) reached US\$ 176.63 million (14.23%), squid-cuttlefish reached US\$ 176.63 million (14.23%), squid-cuttlefish reached US\$ 176.63 million \$ 131.94 million (10.63%), crabs reached US\$ 105.32 million (8.48%), and seaweed reached US\$ 53.75 million (4.33%) (Ministry of Marine Affairs and Fisheries of the Republic of Indonesia, 2020).

The level of fish consumption in the community in the period 2015-2019 increased as in 2015 reached 1397 figures, in 2016 reached 1462 numbers, in 2017 reached 1594 numbers, in 2018 reached 1723 numbers, and in 2019 reached 1852 figures (KKP Statistics). It shows that people in Indonesia are aware of the importance of eating fish and can also be a potential for the development of processed fishery products such as making protein concentrates from marine fish.

Fish protein concentrate is a processed product in the form of flour produced by eliminating fats, minerals, carbohydrates, and water using organic solvents by pressing, drying, or extracting to produce a high protein concentrate of at least 50-70% and used to add protein from low-protein foodstuffs (Ibrahim 2009). FPC creation is adapted to the properties of proteins and component solubility to be eliminated or minimized.

Protein concentrate is divided into three types, i.e. type A with a minimum protein content of 67.7%, maximum fat of 0.75%, odorless fish, bland, and colorless, type B with a fat content of < 3%, and fish smell if added to foodstuffs, as well as type C such as fishmeal in general in good hygiene conditions with a fat content of > 10% and still smell of fish (Riewpassa, 2018). Producing FPCs with the best quality needs to pay attention to factors such as fish type, extraction method and time, procedures, and raw materials (Riewpassa 2014). FPC quality determination is done based on FAO requirement (1976) which includes protein content, fat content, baur value, and white degree.

Generally, all fish meat can be used as raw materials for making protein concentrates including seawater fish. Seawater fish is used as raw materials because of the variety of fish, much in demand by the public, high protein content, and utilization not in all parts to produce byproducts, uneven types of fish that are economically high, as well as processed fishery products are still not much for fishmeal. Therefore, this review article aims to study the types of sea fish that can be processed into FPCs, FPC creation methods, and FPC characteristics of sea fish from various research results in Indonesia.

2. TYPES OF SEAWATER FISH PROCESSED INTO FPC

Here are the types of seawater fish that have the potential to be processed into FPCs

2.1 RED SNAPPER

Red snapper is one of the commodities of high-quality marine fisheries. In common red snapper fishing species such as *Lutjanus malabaricus*, *L. johni*, *L. sanguineus*, and *L. sebae* (Badrudin and Barus, 1989). Classification of red snapper as follows (Saainin, 1984).

Phylum: *Chordata*

Class: *Pisces*

Order: *Percomorphi*

Family: *Lutjanidae*
Genus: *Lutjanus*



Figure 1. *Lutjanus sebae*
Source : fishIDER

Lutjanus sebae has a very tall body with a fairly large preoperculum notch, has 10 soft spines on anal fins, 11 hard spines, and 15 –16 soft spines on dorsal fins. The adult *L. sebae* has a dark red color while juvenile pink with a dark red band, on the fins it is darker in color. *L. sebae* at juvenile size is sold as ornamental fish. Red snapper has fast growth properties, is tolerant of turbidity and salinity, low cannibalism, and is resistant to disease (Melianawati and Aryati 2012). *Lutjanus sebae* has a maximum length of 116 cm with an average length of 60 cm, a maximum weight of 32.7 kg, and a maximum age of 40 years (Fishbase).

Lutjanus sebae has a wide habitat that can be found in tropical waters and subtropics at a temperature of 22.9–28.5°C, a depth of about 5–180 m with coral reef habitats and sandy substrates. In juvenile measuring, less than 20 cm are generally found in murky waters such as near beaches, mangroves, offshore reefs, or shallow coastal bays. The red snapper will pass the ruaya towards the deep waters as an adult and will return to the shallow waters in winter (Fishbase). *L. sebae* belongs to the carnivore with the main diet of small fish, shrimp, squid, crab, stomatopods, cephalopods, and benthic crustaceans (Melianawati and Aryati 2012).

L. sebae adults create medium or solitary size groups (Scott 2007). At the time of ripening the gonads are first estimated at the age of 9 years, a measure in which 50% of the population becomes adults at FL 61–63 cm. The size of adult males is larger than that of females due to slower growth in adult females. *L. sebae* will form groups when mass spawning and spawning occurs between October and April (fishIDER).

Production of red snapper in Indonesian waters in the period 2015-2018 was volatile, namely in 2015 reached 239,673 tons, decreased slightly in 2016 to 232,112 tons, in 2017 it increased to 505,434 tons, and decreased again in 2018 to 348,620 tons (Statistics-KKP). Generally caught with fishing rods, bubu, and deep tensile nets and marketed in fresh, salty dry, and frozen (Fishbase)

2.2 ANCHOVIES

Anchovies are the cheapest source of protein and calcium and are easy to find in all corners of Indonesia. Processed products of anchovies both fresh and dry have the highest protein and calcium content and all parts of the body can be consumed so that there is no waste from the processing of anchovies. At 100 grams of fresh anchovies contain energy 77 kcal,

protein 16 gr, fat 1 gr, calcium 500 mg, phosphor 500 mg, iron 1 mg, and Vit A 47 mg and Vit B 0.1 mg (Aryati and Dharmayanti 2014).

Classification of anchovies as follows (Hutomo *et al.* 1987):

Phylum: *Chordata*
Class: *Pisces*
Order: *Malacopterygii*
Family: *Clupeidae*
Genus: *Stolephorus*
Species: *Stolephorus sp.*



Figure 2. *Stolephorus sp.*

Source : cerita pesisir

Anchovies have a fusiform or compressed body and there are silvery-white lateral lines. Anchovies have caudal fins that do not join anal fins, have abdominal spines in pectoral and ventral fins, and have loose, small, thin scales. The color is a bit reddish or transparent. Anchovies are small between 6–9 cm in size, but *S. commersoni* and *S. indicu* can reach 17.5 cm (Nontji 1993).

Anchovies include pelagic fish that inhabit coastal waters and estuary with salinity between 10–15‰ and temperatures of 26–29°C. Anchovies are omnivorous because they have pointed teeth, stomach, and intestine size shorter than their body length and feed on fish larvae, bivalve and gastropod larvae, copepods, ostracods, annelids, pteropods, and diatoms. Anchovies live in groups of hundreds to thousands, but in large anchovies live solitary (Hutomo *et al.* 1987).

Anchovies migrate due to the changing seasons of the waters and occur annually in certain periods. Spawning anchovies coincide with the change of season from the northwest season to the southeast season in April-May or December-January with the peak of spawning is not always the same every year (Hutomo *et al.* 1987). Anchovies production in the period 2015-2018 was volatile, namely in 2015 reached 221,073 tons decreased in 2016 to 217,398 tons and then increased in 2017 to 294,006 tons, and decreased again in 2018 to 170,842 tons (Statistics-KKP).

2.3 SUNGLIR FISH

Sunglir fish is a pelagic fish that is much loved by the public because of its good taste and affordable price. Sunglir fish is a fast swimmer fish that has the name of local dares fish, sea salmon, or rainbow fast runner fish (urbasa *et al.* 2014)., Classification of sunglir fish as follows:

Phylum : *Chordata*
Class : *Pisces*
Order : *Actynoprygii*
Family : *Perciformes*
Genus : *Carangidae*
Species : *Elagatis bipinnulata*

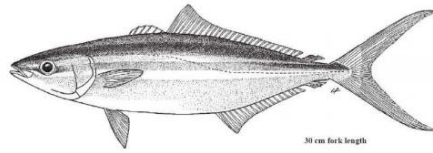


Figure 3. *Elagatis bipinnulata*
Source : Carpenter dan Niem (1999)

Sunglir fish have a long round body shape, tapered head, and muzzle, smallmouth, short pectoral fins, light blue lateral lines, bluish-green body on the back but white on the abdomen and dark fins with yellow color, have a thick midlateral ribbon (Jalanidhitah 2014 in Urbasa 2014), there are finlets on dorsal and anal fins, jaws with teeth on the jaws and tongue, cagak tail fin (Ministry of Marine Affairs and Fisheries 2012). Sunglir fish grow to a maximum length of 107–180 cm on average 90 cm with a maximum weight of 46.2 kg and can live up to 6 years (Fishbase).

Sunglir fish include pelagic coral fish that inhabit coral coastal waters but can also be found in the high seas with a depth of about 150–200 m, generally 2–10 m, with a temperature of 22.8–28.8°C (Fishbase). Sunglir fish distribution areas throughout Indonesia's coastal and coral waters, Bay of Bengal, Gulf of Siam, South China Sea, Filipina Australia (Indonesian Institute of Research Sciences 2010), Liguria Sea, West and East Indian Ocean, Western Central Pacific, Atlantic (FAO 2017). Sunglir fish belong to carnivorous fish (predators) that feed on fish, squid, larvae, or fish eggs, isopods, amphipods, megalops, shrimp, and seaweed (Yesaki 1967). Sunglir fish generally live solitary but will temporarily form hordes. Breech fish caught on average measuring 30-50 cm using Muro Ami, fishing rods, gill nets, and purse seine (Indonesian Institute of Research Sciences 2010). Sunglir fish production in Indonesia in the period 2015-2018 is volatile, namely in 2015 - 2017 decreased from 14,134 tons, 11,396 tons, to 5,294 tons and increased in 2018 to 7,503 tons (Statistics-KKP). Sunglir fish are generally marketed fresh, marinated, dried, and frozen for shichimi (Fishbase).

2.4 MACKEREL

Mackerel is an important and high-economy fish due to the increasing demand from domestic and the world. Mackerel contains high quality proteins and vitamins that support the growth and resilience of the body. Classification of mackerel as follows (Sheedy, 2006) :

Phylum	: Chordata
Class	: Actinopterygi
Ordo	: Perciformes
Family	: Scombridae
Genus	: <i>Scomberomorus</i>
Species	: <i>Scomberomorus commerson</i>



Figure 4, *Scomberomorus commerson*
Source : greeners.co

Mackerel has an elongated body shape, solid flesh, slippery skin, and has no scales except on lateral lines. The mouth is wide, the jaws are strong and dense, and the ceiling is small serrated. The back is grayish-blue with silver scales on the abdomen and fringes of the body, many thin vertical bands are wavy. There are two dorsal fins and a finlet behind them, a clawed tail fin. It has a maximum length of 240 cm with a maximum weight of 70 kg, generally 120 cm in length, and matures the first gonads at a length of 85 cm (fanbase).

Mackerel includes pelagic fish that inhabit coral reefs, lagoons, continental shelf banks, and shallow coastal waters at depths of 10–70 m, temperatures of 22.8–29°C, low maternity, and high turbidity (Fishbase). Pelagic fish distribution is quite wide covering the Western Pacific, Australia, Indonesia, Fiji, Japan, China, Indonesia, the Mediterranean Sea, and St. Helena, this can be due to its migratory nature (Fishbase and McPherson 1993). Mackerel includes carnivorous fish with the main meal of anchovies, squid, shrimp, clupeids, and carangids (Fishbase).

Adult mackerel lives solitary but juveniles and young fish live to form small hordes (Collette 2001). Mackerel production in Indonesia in the period 2015–2018 was volatile, in 2015 424,890 tons, decreased in 2016 and 2017 to 423,880 tons and 325,561 tons but increased in 2018 to 507,626 tons (Statistics-KKP). Mackerel are caught using jarring isang, bubu, trawler center, and trolling and marketed in a fresh state, dried, marinated, processed products such as meatballs, pempek, crackers, smoked fish, and canned fish (Fishbase).

2.5 TUNA FISH

Tuna fish is one of the main export commodities due to the many interests both domestic and the world so that it is highly economical. Tuna fish belong to the family Scombridae which has several types of fish such as yellowfin tuna, bigeye, southern Bluefin tuna, albacore, and tuna dog teeth. Classification of tuna fish as follows (Saanin 1984) :

Phylum : Chordata
Class : Teleostei
Ordo : Perciformes
Family : Scombridae
Genus : Thunnus
Species : *Thunnus alalunga*



Figure 5. *Thunnus alalunga*

Source : united fisheries

Albacore tuna fish have torpedo bodies with taper heads and slippery bodies. Tail fins are clawed with dorsal, anal, ventral, pectoral fins have arches to reduce friction during rapid swimming, and tail fins are scaly. The body is silver and will fade to the abdomen (Ghufron and Kordi 2011). The smallest tuna albacore with a maximum length of 140 cm and an average length of 100 cm, the length mature of 85-90 cm, a maximum weight of 60.3 kg, maximum age recorded 9 years. Albacore tuna include epipelagic and mesopelagic fish up to a depth of 600 m with a temperature of 8.8–21.2. Albacore tuna are carnivores that prey on small fish, crustaceans, mullets, and squid (Fishbase).

Tuna fish are migratory so that the wide distribution in tropical and subtropical oceans includes Indonesia, Australia, the Mediterranean Sea, and the Western Pacific (Fishbase). Tuna production in Indonesia in the period 2015-2018 increased annually to 250,485 tons, 271,856 tons, 293,233 tons, and 409,024 tons. Tuna is caught using fishing rods, albacore tuna are captured mostly offshore because albacore love soft water, blue, and temperatures where it is not cold nor warm. Tuna is marketed when fresh, smoked, baked and fried (Fishbase).

3. RESULTS AND DISCUSSION

Research conducted Yusuf *et al.* (2019) on protein concentrates of flying fish eggs with isopropyl alcohol solvent for 3 hours extraction resulted in EFPC flying with a protein content of 33%, fat 2%. Low protein value is due to repeated extraction and influenced by decreased fat and water content during extraction and drying, lower fat content than EFPC mragal by 8,8% in Chamalaiah *et al.* (2013) and EFPC tuna and red snapper respectively 2,83% and 3,75% in Wiharja *et al.* (2013).

Based on FAO (1976) on FPC type classification, EFPC flies included in FPC type B. EFPC characteristics fly based on functional properties as follows:

Table 1. Best EFPC Flying Fish Functional Properties Characteristics Results

Sifat Fungsional	Nilai
Kapasitas Emulsi (mL/g)	22,4
Densitas Kamba (g/mL)	0,81
Kapasitas Buih (mL)	2,43
Daya Serap Air (mL/g)	5,81
Daya Serap Minyak (g/g)	1,68
Stabilitas Buih (10 menit)	0,38

Source : Yusuf *et al.* [2019]

The results showed that the value of EFPC emulsion capacity flew higher than goldfish and Greasy grouper values of 6,5 mL/g and 5,5 mL/g respectively in Rao (2014) and Barramundi studies with a value of 12 mL/g but lower than cork fish with a value of 56 mL/g, this showed that the power to absorb water and oil in a balanced manner was better in cork fish. Bulky density value in EFPC flew higher than mragal 0,77 g/mL in Chalamaiah *et al.* (2012) and greasy grouper 0,75 g/mL but lower than mas 0,83 g/mL in Rao research (2014), this showed the material of rich greasy grouper is bulkier than flying fish.

EFPC froth capacity flew and froth stability was lower than goldfish at 26 mL and 12 mL respectively and greasy groupers were 56 mL and 12 in Rao (2014). EFPC water absorption is higher than EFPC mas 1,78 mL/g, greasy grouper 1,99 g/mL in Rao (2014), and tuna 5,38 g/mL, but lower than the red snapper 6,25 g/mL in Wiharja *et al.* (2013) and EFPC goldfish, it showed better water absorption of EFPC mas, greasy grouper, and tuna than flying fish and red snapper. EFPC oil absorption is lower than EFPC tuna 1,77 g/g, red snapper 1,89 g/g in Wiharja *et al.* (2013) study but higher than mas 0,83 g/g and greasy grouper 1,01 g/g in Galla *et al.* (2012), this showed better oil absorption of EFPC mas and greasy grouper than EFPC flying, tuna, and red snapper.

Research conducted by Rieuwpassa *et al.* 2014 on the protein concentrate of cakalang fish eggs with isopropyl alcohol solvent for 3 hours of extraction of deffating process resulted in EFPC cakalang with protein content of 71,79%, fat 2,78%, and odor value close to neutral

and good white degree. EFPC cakalang has 7 essential amino acids and 5 non-essential amino acids, as well as 2 semi-essential amino acids with a total of 849,79 g/g of protein.

Based on FAO (1976) on FPC type classification, EFPC cakalang is included in FPC type B. Characteristics of EFPC cakalang based on functional properties as follows:

Table 2. Best EFPC Cakalang Functional Properties Characteristics Results

Sifat fungsional	Nilai
Daya serap air (ml/g)	1,57±0,01
Daya serap minyak (g/g)	1,82±0,01
Kapasitas emulsi (%)	81,65±0,24
Densitas kamba (g/ml)	0,51±0,00
Kapasitas buih (ml)	1,90±0,21
Stabilitas buih (10 menit)	0,22±1,06

Source : Rieuwpassa *et al.* [2013]

The results showed lower water absorption of EFPC cakalang compared to EFPC tuna and red snapper which has a value of 5,38 g/mL and 6,25 g/mL in Wiharja *et al.* (2013), it showed better water absorption of EFPC cakalang than tuna and red snapper. EFPC cakalang oil absorption has a higher value compared to tuna fish 1,77 g/g, lower than red snapper 1,89 g/g in Wiharja *et al.* (2013) and hake fish 4,67 g/g in the study Pires *et al.* (2012), it shows hake fish have better oil absorption ability than skipjack.

The density value of EFPC cakalang bulky is lower than EFPC mragal of 0,77 g/mL in Chamalaiah *et al.* (2011). Functionally, the resulting EFPC has the ability of oil absorption, water absorption, emulsion capacity, good quality bulky density to be used as additives, substitutions, and fasteners of high protein-based product applications.

Research conducted by Rieuwpassa *at al.* 2018 on Physical-Chemical Characteristics of Sunglir Fish Protein Concentrate (*Elagatis bipinnulatus*) with ethanol solvent 90% for 3 hours extraction,

Table 3. Best FPC Sunglir Functional Properties Characteristics Results

Parameter Kimia	Jumlah
Protein (%)	77.34
Lemak (%)	1.22
Air (%)	9.34
Abu (%)	3.38
Parameter fisiko	
Bau	2.56 (aroma ikan lemah)
Derajat putih (%)	54.52
Densitas kamba (g/ml)	1.04
Daya serap air (g/ml)	0.53
Daya serap minyak (g/g)	2.10

Source : Rieuwpassa *at al.* [2018]

From the following table, it can be seen that Sunglir Fish FPC produces a fairly high protein content of 77,34%, a fairly low fat of 1,22%, a smell of 2,56%, and a white degree of 54,52%.

Sunglir fish FPC have a density of bulky of 1,04 g/ml. For water absorption or ability to hold water both from outside and in foodstuffs (Riewpassa *et al.* 2018) in Sungli fish is 0,53 g /ml. In the FPC content sungli fish is composed of 15 types of amino acids, of which 8 are essential amino acids, and 7 non-essential amino acids.

Research conducted by Laili *et al.* (2021) on Characteristics of Protein Concentrates Cunang Fish (*Muraenesox talabon*) Using Ethanol Solvents With Different Times using Nurjannah Method (2008) in Karnila (2012) which has been done a little modification, cunang fish soaked in ethanol with a ratio of 1;3, then extracted in the refrigerator with solvent soaking time difference 12, 18, 21 hours.

Table 4. Best FPC Cunang Functional Properties Characteristics Results

Kandungan gizi	Presentase(%)		
	12 (P1)	18(P2)	24(P3)
Protein (%bk)	71,66±3,12	75,18±2,87	78,73 ± 8,11
Lemak (%bk)	3,99±0,13	3,50±0,17	3,20 ± 0,11
Abu (%bk)	5,86±0,61	4,31±0,57	6,19 ± 1,61
Air (%bb)	8,42±2,07	8,35±1,19	7,47 ± 1,56

Source : Laili et al. [2021]

From the following table can be seen that Cunang fish FPC using Ethanol solvents with different times produce different protein levels, with the highest protein content is in the 24-hour cunang fish FPC which is extracted for 78.73%, the lowest fat is at 24-hour extraction with a fat content of 3.20%, and the lowest moisture content is 24-hour extraction s7.47%. Water content and fat in extraction are 24 hours lower, due to the length of dissolving affects the fat and water content, but has no noticeable effect on proteins. While the absorption of water at the third time has no real effect, namely having an absorbency of 1 ml of water.

4. CONCLUSION

Based on the results of various articles and other literature obtained the conclusion that the types of sea fish that can be processed into FPCs are tuna, mackerel, anchovies, snapper, and Sunglir. FPC creation method can be done by reduction, way of "wholemeal", dry reduction method, and way of extracting with solvent extraction. Karakteristik FPC obtained from various research conducted is highly dependent on the type of fish and the method of making FPCs used.

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