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An evaluation of potential fatty acids nutrition in snakehead fish (*Channa striata*) waste

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Abstract

Channa striata is a freshwater fish commonly found in Asia. Recently, the number of catches and aquaculture products has increased along with their uses. This fish is widely used for food and traditional medicinal products in Indonesia, and its high usage has resulted in a large amount of waste. Therefore, this study aims to determine the potential fatty acids nutrition of snakehead fish waste. Gas Chromatography Flame Ionization Detector (GC-FID) was used to analyze the fish's head, intestine, skin, bone, fins, and tail according to their fatty acid profiles. Additionally, the moisture, protein, ash, and lipid contents were also conducted. The results showed that the proximate content of channa waste still contains 17.09-19.02% protein, 2.45-4.26% lipid, 7.05-16.42% moisture, and 1.30-30.18% ash. Furthermore, the total amount of EPA and DHA detected was 0.19% and 7.97% in the head, 3.93% and 6.84% in the innards, 0.1% and 9.41% in the bones, 0.1% and 9.83% in the fins and tail. In conclusion, the fatty acid profile of snakehead fish waste shows that it can be used for feeding purposes by both humans and animals.

1. Introduction

Snakehead fish is one of the commercialized freshwater fish species among the channa family, which are a group of medicinal freshwater fish that are widely studied (Rahman *et al*., 2018). *Channa striata* is well-known as the snakehead fish in Indonesia and Malay (Sasongko *et al*., 2017). Its popularity as a therapeutic agent in traditional medicine in the Asian community, particularly in Indonesia, Malaysia, Brunei, and Thailand, has been supported by science and studies that reveal its high nutritional content for health (Shafri and Abdul, 2012). Therefore, it is usually consumed as a traditional food rich in proteins, fatty and amino acids, and other essential nutrients for energy boosters during illness (Pratama *et al*., 2020; Pasaribu *et al*., 2020).

The total global catch and aquaculture productivity of snakehead fish in 2016 was 92,523 tons (FAO, 2019). Its production in Indonesia increases annually, and the number of catches at the end of 2018 is almost 100,000 tons and not from cultivation (Sasongko *et al*., 2022). Most snakehead fish production is used in traditional medicine and food industries. In traditional industrial medicine, solid biological waste such as the head, intestine, skin, bone, fins, and tail, significantly affects the environment. Furthermore, diverse treatment technologies are used to valorize fish waste (Shanthi *et al*., 2021), and the annual global production is around 75.24 megatons (Murthy *et al*., 2018). Fish is mostly used worldwide; thus, it generates a lot of waste because it spoils quickly and has parts that can't be eaten (Thirukumaran *et al*., 2022). However, these wastes are known to have nutrients that are good for human and animal health when they are further processed (Desai *et al*., 2022).

Snakehead fish have been proven to contain monounsaturated, and polyunsaturated fatty acids, good quality protein, as well as vitamins and minerals composition (Sasongko *et al*., 2018). However, its fatty acid profile has not been extensively studied. Therefore, this study aimed to analyze the fatty acid content of snakehead fish waste, namely the head, intestine, bone, fins, and tail. The price of snakehead fish is quite high compared to other types of fish for human consumption, making this study important. Additionally, the advantages of snakehead fish waste enable its use in the future.

2. Materials and methods

2.1 Materials

The sample used in this study was a 6-month-old snakehead fish (*Channa striata*) obtained from the Griya

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Arka Kendal Farm in Central Java, Indonesia, weighing 800-900 g. A total of 11 kg of fresh snakehead fish are separated from the neck (oblongata), fins, tail, and head, and then the entrails and scales are removed.

2.2 Sample preparation

Every part of the fish considered waste except the intestines is dried by heating at 50°C for 24 hrs in an oven. The dried samples were ground to a powder, stored in a tightly closed container at room temperature, and protected from direct sunlight until further analysis.

2.3 Determination of proximate

The moisture, protein, ash, and lipid contents of snakehead fish waste were determined according to the Association of the Official Analytical Chemists protocol (AOAC, 2006).

2.4 Determination of fatty acid profile

The hydrolysis process was carried out by adding 5mL of concentrated HCL to each 1-5 mL sample taken. The samples were heated in a water bath at 80°C, boiled for 3 hrs, and then chilled. Afterwards, 25 mL of diethyl ether and petroleum ether (1:1) were extracted and homogenized by vortex and left to stand until it settled. The top layer (oil phase) was pulled and steamed in a water bath using N_2 gas. For the methylation process, which consists of a lathering reaction, 0.5 mL of sample was drawn and mixed with 1.5 mL of methanolic sodium solution. It was then covered and heated at 60°C for 5-10 mins, shaken, and left to chill. Subsequently, 2 mL of Boron trifluoride methanoate was added and heated 60°C for 5-10 min, then chilled. Next, 1 mL of Heptane and 1 mL of saturated NaCl were extracted from the sample. The top layer was withdrawn and placed in an Eppendorf and injected into the GC-FID (Shimadzu 2010). Less than 0.1% of the fatty acid composition was detected and considered to have no significant value (Putri *et al.*, 2019).

3. Results

Snakehead fish is frequently utilized to cure and overcome health issues, including stunting. However, its usage in large quantities produces a lot of waste because most parts of the Snakehead fish are waste, such as the head, fish innards, bones, fins, and tail. Figure 1 shows the number of fish parts before and after the oven process. It also showed that the part not consumed is bigger than the flesh fillet. After drying, the total weight

Table 1. The proximate profile of snakehead fish's head, intestine, bones, fins, and tail.

Component	Part of snakehead fish (%)			
	Head	Intestine	Bones	Fins and Tail
Protein	18.22±0.02	19.02±0.25	17.09±0.22	18.81±0.13
Lipid	2.65±0.12	4.26±0.22	4.05±0.18	2.45±22
Moisture	16.42±0.21	14.89±0.28	7.05±0.12	8.05±0.12
Ash	12.11±26	1.30±0.16	30.18±0.23	1.44±0.18

Table 2. The fatty acid profile of snakehead fish's head, intestine, bones, fins, and tail.

Fatty Acid Profile	Concentration (% relative)			
	Head	Intestine	Bones	Fins and Tail
M Tridecanoate	<0.1	0.34	<0.1	<0.1
Myristoleic Acid Methyl Ester	0.28	<0.1	0.22	0.16
M Pentadecanoate	4.65	<0.1	3.71	3.58
M cis-10-pentadecenoate	<0.1	3.53	<0.1	<0.1
M Palmitate	0.87	0.7	0.96	1.07
M Palmitoleate	1.56	1.16	1.38	1.24
M Stearate	35.56	30.34	33.75	33.31
M Linoleate	2.07	1.65	1.55	1.57
M cis-11-eicosenoate	36.62	<0.1	40.26	38.12
M Heneicosanoate	<0.1	39.6	<0.1	<0.1
M cis-11-14-eicosadienoate	2.42	8.72	<0.1	<0.1
M Behenate+M cis-11-14-17-eicosatrienoate	<0.1	<0.1	2.28	2.28
M cis-8-11-14-eicosatrienoate	<0.1	3.18	<0.1	<0.1
M Tricosanoate	0.55	<0.1	0.6	0.6
M cis-5-8-11-14-17-eicosapentaenoate (EPA)	0.19	3.93	<0.1	<0.1
M Lignocerate	5.26	<0.1	3.94	5.3
M Nervonate	2	<0.1	1.94	2.95
M cis-4-7-10-13-16-19-docosahexaenoate (DHA)	7.97	6.84	9.41	9.83

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of the head was 874 g (28%), meat 1306 g (41%), fish innards 440 g (14%), bones 310 g (10%), and fins and tail 226 g (7%).

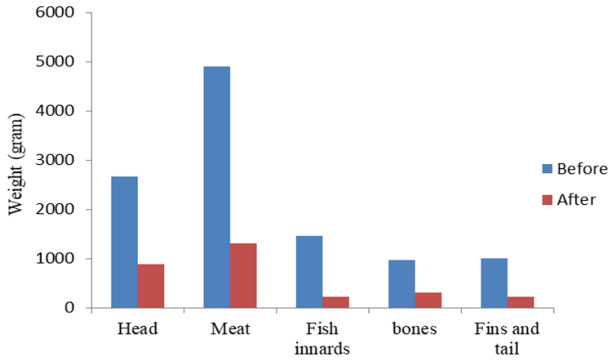

Figure 1. The difference of weights of snakehead fish before and after oven drying.

Table 1 shows that the proximate content of snakehead fish waste contains 17.09-19.02 protein, 2.45-4.26% lipid, 7.05-16.42% moisture, and 1.30-30.18% ash. Table 2 shows the fatty acid profiles in the powdered head, fish innards, bones, fins, and tail of snakehead fish as detected by gas chromatography. The total amount of EPA and DHA detected in the head (0.19% and 7.97%), fish innards (3.93% and 6.84%), bones (0.1% and 9.41%), and fins and tail (0.1% and 9.83%) remained unchanged indicating that the waste is useful in other ways.

4. Discussion

Many studies have developed fish-based food supplements. Furthermore, oil or fat consists of fatty acid units that are grouped based on saturation levels, such as saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). The difference in chemical bonds influenced the saturation level of fatty acids. Figure 1 depicts the study's results, which showed that more waste is consumed than meat or the proteinous raw materials utilized in traditional medicine. In some types of fish, for every ton taken, about the same quantity of waste is wasted either by ocean dumping or land disposal (Illera-Vives *et al.*, 2015). Furthermore, the use and subsequent fish processing waste are determined by local conditions and industrial structure (Ahuja *et al.*, 2020). Fish waste can also be converted into proteins, amino acids, peptides, collagen, oil, minerals, enzymes, flavors, and other substances used in food, feed, and medicinal applications (Ghaly *et al.*, 2013; Eilertsen *et al.*, 2017). Those that do not fulfill appropriate food or feed criteria might be utilized to produce fuel or fertilizers (Dao and Kim, 2011; Fernandez-Salvador *et al.*, 2015).

Generally, fish's moisture, protein, ash, and fat content are used to determine its nutritional value (Stansby, 1962). Table 1 shows the protein content of channa waste, where the head, intestine, bones, fins, and tail are still high. Each component of channa waste produces a different amount of proximate. The difference in proximate composition in each part of the fish body is influenced by many factors. The head and bones are composed of collagen and gelatin, which are protein-derivative products generated by numerous amino acids (Usman *et al.*, 2022). Protein content measurements revealed almost identical values in each part of the snakehead fish. In this study, the moisture content was influenced by the oven process, which will remove a lot of water from the fish. The results showed that the water content in the head and intestine was relatively higher. This is influenced by the weight of the initial sample where the amount of waste from the head and intestines is greater than the bones, fins, and tail (Figure 1). High moisture content may degrade polyunsaturated fatty acids, increase fish sensitivity to microbes, and reduce fish quality for prolonged preservation (Olagunju *et al.*, 2012). High moisture content may also aid metabolic processes and solubilize some components (Ayanda *et al.*, 2019). Ash is an inorganic byproduct of organic combustion. Ash content is determined by a material's mineral composition, purity, and cleanliness (Emmanuel *et al.*, 2011). The results of this study showed that the ash content in the bones was higher than in other parts of the fish. Mineral content in fish is influenced by environmental factors and feed consumption, where bones are known to contain a lot of minerals. Channa's waste body parts are sources of nutrition commodities due to their high protein content, similar to the lipid profile shown in Table 2. The relatively high amounts of fatty acid indicate that it has the potential to be used by humans or for veterinary purposes. Polyunsaturated fatty acids (PUFAs) are also important for good health. Furthermore, fish processed into powder, oil, or other forms has been extensively studied to develop nutritional supplements and health treatments (Sasongko *et al.*, 2022).

The protein and fatty acid content in snakehead fish protect and repair tissues and organs damaged by free radicals due to oxidative stress (Frenay *et al.*, 2016). Snakehead fish has several uses, including treatment of wounds, reducing pain and internal inflammation, as additional energy during illness, accelerating the recovery of postpartum mothers either normal or sectio caesarea delivery, as nutritional support to reduce pain, and accelerating the healing process of post-operative patients (Miles *et al.*, 2001; Daisa *et al.*, 2017; Abdulgani *et al.*, 2020). Additionally, they play a significant role in the inflammation and proliferation stage of wound healing and serve as a source of energy (Phan *et al.*, 2021; Ramadhanti *et al.*, 2021; Taslim *et al.*, 2022). A previous study reported the fish's fillet, mucus,

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and roe can be used to determine the fatty acid composition, but no other parts such as bones were determined. The study reported the fatty acid composition of snakehead fish fresh fillet by revealing the arachidonic acid (AA) content, a precursor of prostaglandins that may initiate blood clotting and is responsible for tissue growth, but almost no eicosapentaenoic acid (EPA) (Jais *et al*., 1994).

4. Conclusion

Snakehead fish wastes such as the head, intestine, skin, bone, fins, and tail contain different amounts of EPA and DHA. Therefore, it is implied that snakehead fish wastes can be used as a source of nutrition.

Conflict of interest

The authors declare no conflict of interest.

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