

Analysis of nutritional content and heavy metals of suckermouth catfish (*Pterygoplichthys pardalis*) in Lake Sidenreng, South Sulawesi, Indonesia

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Abstract. Hasrianti, Armayani M, Surianti, Putri ARS, Akbar AH. 2022. Analysis of nutritional content and heavy metals of suckermouth catfish (*Pterygoplichthys pardalis*) in Lake Sidenreng, South Sulawesi, Indonesia. *Biodiversitas* 23: 3539-3545. Suckermouth catfish (*Pterygoplichthys* spp.) is one type of freshwater fish that belongs to the category of invasive fish (invasive alien species) in Indonesia based on the regulation of the Indonesian Minister of Marine Affairs and Fisheries Number PER.17/MEN/2009. The presence of suckermouth catfish in Lake Sidenreng with a high population level and increasing over time has resulted in this species dominating the waters. The many impacts caused and the solution has not been found to eradicate the fish, so we need an alternative that can be used to utilize suckermouth catfish, for example, as food to be processed into fishery products. In order to be used as raw material for processed food, a study is needed to determine the nutritional content and heavy metal content in suckermouth catfish. Based on the results of the analysis of the content of crude protein, crude fat and carbohydrate content in the meat of a large (40.3 cm), the content values were 14.52%, 0.49% and 0.21%, while the crude protein, crude fat and fat content were Carbohydrates contained in the meat of suckermouth catfish which are smaller in size (21 cm) are 14.58%, 0.52% and 0.09%. Heavy metals Pb, As, Cd and Hg contained in the meat and scales of suckermouth catfish are also below the metal contamination threshold required based on SNI 2729:2013 so that the fish can be categorized as fish fit for consumption and can be processed into various fishery products with economic value.

Keywords: Contamination, proximate, Suckermouth catfish, water quality

INTRODUCTION

Suckermouth catfish (*Pterygoplichthys*) is a type of fish originating from the Amazon River in South America (Armbruster 2004). The suckermouth catfish comes from the Loricariidae family, which consists of 122 genera and 963 species in the world (Fishbase 2021). Based on the list from The Global Invasion of the Suckermouth Armored Catfish Genus *Pterygoplichthys* (Siluriformes: Loricariidae), there are 15 species, including *Pterygoplichthys disjunctivus*, *Pterygoplichthys pardalis*, *P. multiradiatus*, *P. anisitsi*, *P. joselimaianus*, *P. lituratus*, *P. ambrosetti*, *P. parnaibae*, *P. xinguensis*, *P. punctatus*, *P. zuliaensis*, *P. scrophi*, *P. undecimalis* and *P. gibbiceps* (Orfinger and Gooding 2018). Two of these species, *Pterygoplichthys disjunctivus* and *P. pardalis*, are widespread in Indonesia (Patoka et al. 2020).

Suckermouth catfish found in Lake Sidenreng and in Lake Tempe until now has never been used by the people living around the lake either as a source of food that can be consumed or as raw material for feed Lake. It is different from the suckermouth catfish found in the Ciliwung River, the utilization of *Plecostomus* in the Ciliwung River by some people living near the river is otak-otak (a cake made of fish meat and spices), fish balls, shu may (a dimsum-like made of fish meat and spices), and fish crackers (Ernawati

2014). This fish is mostly used because of its relatively cheap price and easy to get (Elfidasari et al. 2019).

In contrast to Suckermouth catfish in Bangladesh and some other countries, they are underutilized due to the high ash and heavy metal content of the meat, so their use is limited both as fertilizer and as human food (Hossain et al. 2018), but some of them also use fish as fish meal, animal feed, crab bait, and surimi (Japanese food) due to its high protein and fatty acid content (CEC 2009). Besides being used as raw material for food and feed, suckermouth catfish can also be used as handicrafts (Caguan 2007), and can also be used for several products such as soap making, collagen products, biofuels, and digestive enzymes (CEC 2009). The use of suckermouth catfish as a food ingredient which depends on the content of heavy metals and nutritional content is the background for the purpose of this study, namely to determine the nutritional content and heavy metals in suckermouth catfish so that the fish can be used as food raw materials for fishery products.

MATERIALS AND METHODS

Sample collection

Samples of research data (suckermouth catfish) were obtained from the catch of gill net fishermen in Teteaji

Village, Tellu Limpoe Sub-district, Sidenreng Rappang District, South Sulawesi, Indonesia, in August 2021. While the samples for testing water quality were obtained at 2 points of fishing areas, namely (i) fishing areas close to residential areas, and (ii) fishing areas far from residential areas.

The fish samples obtained consisted of 40 samples, the fish were measured first. The results of measuring the length of the fish obtained ranged from 21cm-40.3cm. The samples selected for the proximate test and the heavy metal content test were fish that had the longest (i) and smallest sizes (ii). The fish samples were separated from the scales/skins and bones and then the fish meat was analyzed for protein, fat and carbohydrate content as well as heavy metal content.

Procedures

Testing of suckermouth catfish samples to determine the heavy metal content was carried out using the Atomic Absorption Spectrophotometer (AAS) method, which was analyzed at the Makassar Health Laboratory Center (BBLK). The method used in the analysis of heavy metal content in fish meat is based on quality standards. As for the nutritional content test, the Proximate test was carried out at the Nutrition and Food Engineering Laboratory, Faculty of Animal Science, Hasanuddin University. The

proximate tests carried out included analysis of carbohydrate content, water content, ash content, protein content and fat content contained in meat. Testing is carried out using the following procedure.

Carbohydrate level

Carbohydrate content is determined by different methods, namely by calculations involving water content, ash content, protein content and fat content. The following is the equation used in calculating carbohydrate content using the by difference method. 26 Carbohydrate content (%) = 100% – (% moisture content + % ash content + % protein content + % fat content).

Water content

Water content testing was carried out by the following steps: Firstly, the porcelain dish was dried for about 1 hour in an oven at 135°C, then cooled in a desiccator for 15 minutes and weighed. Weighed more carefully, weighing 1 gram and put into a porcelain cup. Then the porcelain dish and the samples in it were put in an oven at 135°C to be dried for 8 hours or overnight. Allowed to cool, then put in a desiccator for an hour and then weighed and the results recorded. Then cooled in a desiccator for 30 minutes, then weighed and the results were recorded.

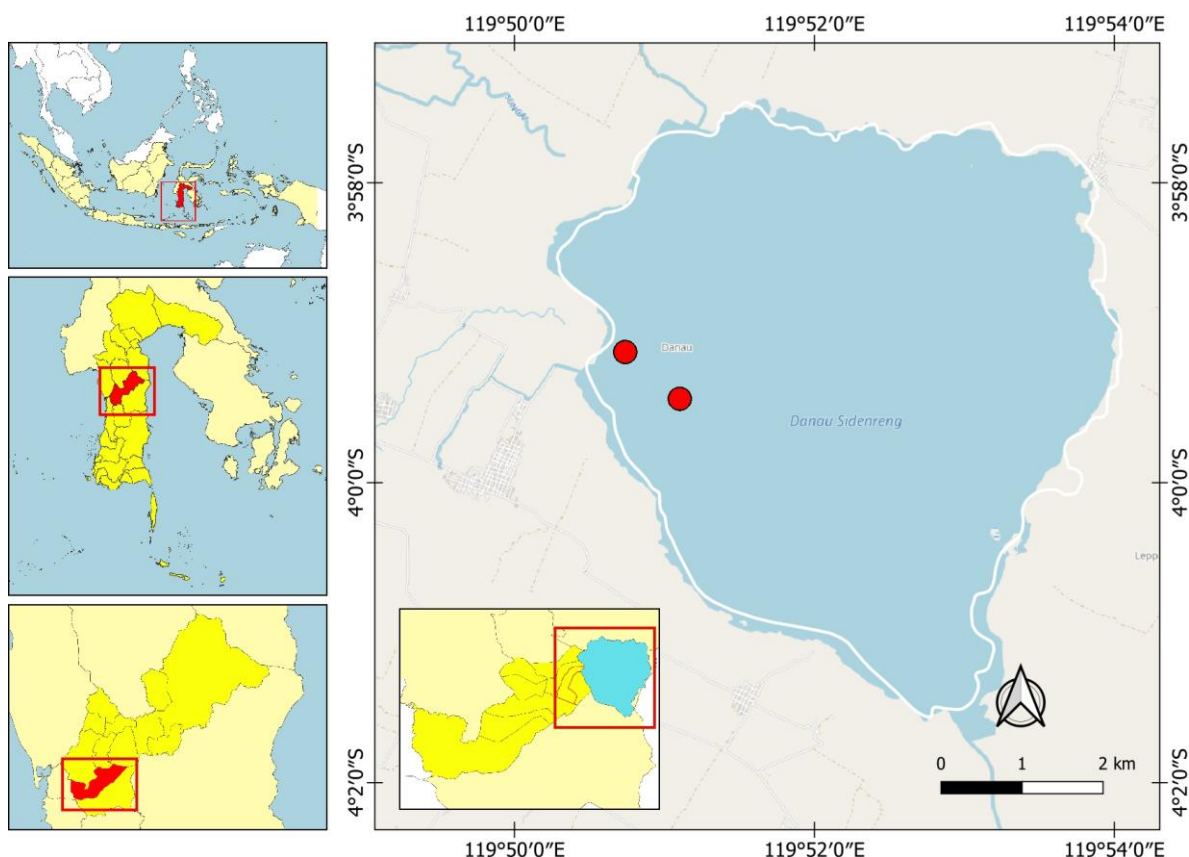


Figure 1. Research location map in Teteaji Village, Tellu Limpoe Sub-district, Sidenreng Rappang District, South Sulawesi, Indonesia

Ash content (AOAC 1993)

Ash content testing was carried out by the following steps: Firstly, the porcelain dish is dried for about 1 hour in an oven at 105°C, then cooled in a desiccator for 15 minutes and weighed. Carefully weighed approximately 1 gram and put into a porcelain cup. Then the cup with the sample in it is put in a furnace at a temperature of 600°C then left for 3 hours until it turns completely into ash. Allowed to cool, then put in a desiccator for an hour and then weighed and the results recorded.

Protein content (Foss Analytical 2003a)

Protein content testing was carried out by the following steps: Grind the sample using a suitable tool or grinder. Weigh the sample 0.2-0.5 grams into the Kjeldahl tube. Adding a certain amount of catalyst (Selenium mix), Added 6 mL of H₂SO₄, homogenized. Samples that have been homogenized are then destroyed for ±1.5 hours until they are clean yellow. After completion of digestion, cool until the sample is completely cold. Samples were analyzed using the Foss tool (KJELTEC) and then record the results of the analysis were obtained. After finishing analyzing, the tool is then turned off.

Fat level (Foss Analytical 2003b)

Fat content testing was carried out by the following steps: The sample is weighed exactly 1 g, put in the lead and covered with cotton. Simbel containing the sample is inserted/placed on Soxtec, the tool is turned on and heated to a temperature of 135, and water has flowed, the lead is placed on Soxtec in the rinsing position. After the temperature is 135°C, put an aluminum cup (weighed) containing 70 mL of petroleum benzene into soxtec, then press start and clock, soxtec is in the boiling position, carried out for 20 minutes. Then Soxtec is pressed in the rinsing position for 40 minutes, then recovery is carried out for 10 minutes, the position of the faucet on Soxtec is in a transverse position. The aluminum cup and fat are put in the oven for 2 hours at a temperature of 135°C, then put in a desiccator, after being cooled, they are weighed.

For testing water quality parameters in Lake Sidenreng, among others, tests for the chemical and physical content of water such as ammonia, nitrate, nitrite, sulfate, phosphate and tests for pH, salinity, biochemical oxygen demand (BOD) and dissolved oxygen (DO) were carried out at the sampling location, and some of the data were tested at the Laboratory of Productivity and Water Quality, Faculty of Marine and Fisheries Sciences, Hasanuddin University. Below are the water quality testing parameters and the data collection methods are presented in Table 1.

RESULTS AND DISCUSSION

Nutrient content

Proximate testing was carried out to determine the content of carbohydrates, protein, fat, ash and fiber contained in the meat of *Pterygoplichthys pardalis*. Proximate test results are shown in Table 2.

Based on the results of the proximate test on *Pterygoplichthys* meat, it was found that the carbohydrate, fat, and protein content had differences in the two samples, namely, the large fish (>40cm long) contained 0.21%, 0.49% and 14.52% while the small fish samples (total length <22cm) contains carbohydrates, fats, and proteins, namely 0.09%, 14.58% and 0.52%. Nurjannah et al. (2005) reported that the protein content in *Plecostomus* was categorized as the freshwater fish group that has a high protein content are <20%, while Elfidasari et al. (2018) stated that the highest protein content in *Plecostomus* reached 50.0517%. Differences in protein content in *Plecostomus* meat can be caused by the age and body size of the fish, the longer the body, the higher the protein in the body. This is because the larger the body size, the greater the fish's ability to synthesize protein in its body optimally. However, due to the presence of heavy metals in *P. pardalis* meat, the fish experienced a decrease in physiological function in protein synthesis, resulting in a decrease in protein content in the body (Elfidasari et al. 2018).

Heavy metal content

Quality and safety of fishery products (fish) are strongly influenced by the content of elements/compounds contained in the fish. Testing the content of heavy metals in suckermouth catfish is intended to determine the level of feasibility and safety of these fish species so that they can be used as food sources (fit for consumption) so that can have economic value. Based on the results of the AAS (Atomic Absorption Spectrophotometer) analysis, the results are shown in Table 2.

Table 1. Water quality data collection methods in the Sidenreng lake water, South Sulawesi, Indonesia

Physical and chemical factors of the waters	Unit	Tools and methods of sampling
Temperature	°C	Thermometer
Salinity	PPT	Refraktometer
pH	-	pH Meter
Dissolved Oxygen	ppm	DO-meter
Biochemical Oxygen Demand	ppm	BOD-meter
Nitrite	ppm	Sulfanilamide (APHA 1989)
Ammonia	ppm	Spectrophotometer
Nitrate	ppm	Spectrophotometer
Total phosphorus	ppm	Spectrophotometer

Table 2. Proximate test results (*Pterygoplichthys pardalis* with a total length of >40 cm, *Pterygoplichthys pardalis* with a total length of <22 cm)

Sample	<i>Pterygoplichthys pardalis</i>	<i>Pterygoplichthys pardalis</i>
Carbohydrate %	0.21	0.09
Water content %	83.87	82.83
Ash level	0.91	1.00
Crude protein level	14.52	14.58
Crude fat content	0.49	0.52
Crude fiber content	-	-

Table 3. Analysis of heavy metal content of *Pterygoplichthys pardalis*

Parameter	Meat (µg/g)	Scales/fins (µg/g)
Arsenic (As)	0.01	0.01
Cadmium (Cd)	<0.01	<0.01
Mercury (Hg)	<0.0005	<0.0005
Lead (Pb)	<0.01	<0.01

Table 4. Results of measurement and testing of water physical and chemical parameters in fishing areas close to residential areas and fishing areas far from residential areas

Physical and chemical factors of the waters	Stations	
	Residential areas	Fishing areas
Temperature (°C)	26.90	25.7
Salinity (PPT)	0.019	0.024
pH	7.11	7.19
Dissolved Oxygen (ppm)	6.40	4.48
Biochemical Oxygen Demand (ppm)	2.56	2.24
Nitrite (ppm)	0.208	0.402
Ammonia (ppm)	0.0055	0.0063
Nitrate (ppm)	0.084	0.312
Total Phosphorus (ppm)	0.1115	0.0618

The results of the AAS (Atomic Absorption Spectrophotometer) analysis showed the heavy metal content in the meat and fish scale samples, namely Arsenic (As) 0.01 g/g, Cadmium (Cd) <0.01 g/g, Mercury <0.0005 g/g and Lead (Pb) of <0.01 g/g. In contrast to the heavy metal content in *P. pardalis* from the Ciliwung river reported by Elfidasari et al. 2020b, which stated that the concentration of heavy metals in *P. pardalis* meat, namely Cd, Hg, and Pb was quite high and exceeded the threshold set by the provisions of the Supervisory Agency. Food and Drugs (BPOM) and the Indonesian National Standard (SNI) are influenced by the concentration of heavy metals such as Cd, Hg and Pb in water and sediment from the Ciliwung River, which is quite high, exceeding the threshold set by Government Regulation Number 82 of 2001 concerning Class III Waters for Fish Farming.

Sidenreng lake water quality

The results of measurements of physical and chemical parameters of water at 2 points of fishing area locations in Lake Sidenreng, which is a habitat for suckermouth catfish, the measurement results are presented in Tables 3 and 4.

Discussion

Table 2 shows that the crude protein content contained in the meat of the suckermouth catfish is 14.52% and 14.58%, it shows that the suckermouth catfish also has a protein content that is not much different from the protein content of eel (*Anguilla anguilla*) 15% and catfish (*Silurus glanis*) 15.3% (Steffens 2006). In addition, the protein content of *Pterygoplichthys pardalis* was higher than snakehead murrel (*Channa striata*) 14.46% and Helicopter catfish (*Wallago attu*) 14.13%, but slightly lower than

Iridescent shark (*Pangasianodon hypophthalmus*) fish which had a protein content of 15.41% (Paul et al. 2018). Protein content in fish can be categorized as low protein if it has a protein content of <15%, and categorized as moderate protein content if the fish has a protein content in the range of 15%-20% and categorized as high protein if the fish has a protein content >20% (Elfidasari et al. 2019). This shows that the crude protein content in suckermouth catfish tends to be not much different from other freshwater fish, which are commonly consumed every day.

The protein content of suckermouth catfish in Lake Sidenreng is 14.58% which is in the low protein category but almost reaches the medium category. While the results of the protein content test in suckermouth catfish from Ciliwung River is 52.9905% which is included in the category of fish that has high protein content (Elfidasari et al. 2019). Basically, the protein content of fish meat depends on the physiological ability of fish to synthesize protein. Biological factors such as fish species, body size, age, and sex of fish can affect the protein content of meat (Badal and Mihir 2015).

Based on the test results, the fat content of the suckermouth catfish is 0.49% and 0.52%, the results indicate that the suckermouth catfish is classified as a low-fat fish. According to Murray and Burt (2001), fish is categorized as low-fat fish if the fat content is 1%, while fish is categorized as high-fat if the fat content is more than >5%. Elfidasari et al. (2019) suggest that *Plecotomus (Pterygoplichthys pardalis)* should be categorized as low fat because its fat content is < 2%. Generally, fish has low-fat content and high protein content.

Heavy metal content the pollution of an aquatic environment greatly affects the organisms that live in these waters. Fish is a source of food that is widely consumed by humans. If the fish has been contaminated, it can cause potential contamination that can have an impact on the health of the human body (Orfinger and Goodding 2018).

Although the heavy metal content in *P. pardalis* meat (Pb, As, Cd and Hg) is below the maximum threshold, consuming foods containing heavy metals continuously can have an impact on health. Chavez et al. (2006) stated that the heavy metal content in *P. pardalis* meat which was within standard limits, should not be ignored because heavy metals in low concentrations tend to bioaccumulate.

Based on the results of the analysis of the heavy metal content in the meat and scales of the suckermouth catfish, it was found that the lead content (Pb) <0.01, this indicates that the heavy metal content of lead (Pb) in the suckermouth catfish is below the threshold for lead content in fish according to quality requirements. and the safety of fresh fish based on SNI 2729:2013 is a maximum of 0.3 mg/kg(µg/g) (BSN 2013). Similar to lead, the content of As, Cd and Hg contained in the meat and scales of the suckermouth catfish is also below the metal contamination threshold required based on SNI 2729:2013, namely 1.0 for As, 0.1 for Cd and 0.5 the maximum limit of Hg elements (BSN 2013).

The results of previous research conducted in Lake Tempe also proved that the content of heavy metals (As, Pb and Hg) found in the meat, scales and bones of

suckermouth catfish did not exceed the metal content threshold required in SNI 2729:2013 (Amir et al. 2020). However, unlike the heavy metal content in *P. pardalis* found in the Ciliwung River, the concentration of these metals is quite high in *P. pardalis* meat exceeding the threshold set by the Indonesian Food and Drug Supervisory Agency (BPOM) and the Indonesian National Standard (SNI) (Elfidasari et al. 2020b).

Pb enters the fish body through the food chain and the respiratory system, namely through the gills or diffusion through the skin surface (Suprpto et al. 2019). Heavy metal contamination in fish organs is strongly influenced by habitat conditions, water pollution levels, length of exposure to pollution and fish-eating habits. Suckermouth catfish status as a predator in its environment so that in this case, predators accumulate more toxic metals in their tissues because metals are able to accumulate in organisms and thus be transmitted to higher levels of the food chain (Winiarska-Mieczan et al. 2018). The low concentration of Pb in the waters of Lake Sidenreng was caused by the environmental conditions that were not polluted, so the concentration of heavy metal content in *P. pardalis* meat was still below the safety threshold.

The heavy metal content of suckermouth catfish in Lake Tempe and Lake Sidenreng, which both have values below the safety threshold is thought to be due to the location of Lake Sidenreng and Lake Tempe directly adjacent and in the rainy season, the two lakes and crocodile lake unite to form waters covering an area of about 35,000 ha (Keates and Pasveer 2004).

The correlation of heavy metals to proteins can be in the form of the immune system. Heavy metals can trigger immunity to fish, so when the body is introduced to foreign compounds such as metals, the immune system will immediately work and produce lots of protein, but this wouldn't increase the protein content of the fish long term as it doesn't relate to growth. In addition, the relationship between heavy metals and protein can be a physiological response of the *Plecostomus* to adapt to environmental conditions. The way fish adapt can help fish survive. The cells in their bodies respond to a major threat. The main threat is toxic waste in rivers such as Pb. *Plecostomus* can produce threat-induced proteins (stress-induced proteins) (Elfidasari et al. 2018).

The water temperature obtained is based on the results of measurements made at the time of data collection in the field, the range of water temperatures can change depending on the intensity of sunlight entering the lake waters. According to Fuller et al. (1999), *P. pardalis* prefers warmer waters because of the higher possibility of food and invasion, while Nico et al. (2012) stated that the water temperature for *P. pardalis* has a range between 21°C-29°C. Under these conditions, *P. pardalis* will breed according to the amount of phytoplankton available in the waters. Phytoplankton at a temperature of 20-30°C is an optimal condition to be able to grow in waters (Effendi 2003).

The pH value of Sidenreng lake water is 7.11 and 7.19, which indicates the waters are alkaline. In contrast to the pH content of the Ciliwung river water, which has a pH

value measurement of 6.5-6.9 (acidic) which can support the life of *P. pardalis* for growth and food (Elfidasari et al. 2020a).

A good DO level for fish growth is above 5 mg/L (Boyd 1990). DO levels is contained in the waters of Sidenreng Lake are 6.40 ppm and 4.48 ppm. The difference in DO value between the first and second location points whose value is below 5 can be caused by turbidity and the amount of waste, especially organic waste that enters the waters (Elfidasari et al. 2020a).

A good BOD value for aquatic biota ranges from 0-10 mg/L (Salmin 2005) the value of Biochemical Oxygen Demand (BOD) at the first location point is 2.56 ppm and at the second location point 2.24 ppm it shows that Sidenreng lake can be categorized as a lake unpolluted.

The Decree of the Minister of Environment (2004) states that the threshold value of nitrate allowed for the benefit of marine life is 0.008 mg/L while the nitrate threshold value of waters set by the US-EPA (1973) is 0.07 mg/L. the nitrate content at the first location point is 0.084 ppm and at the second location point, 0.312 ppm indicates that the nitrate content in the waters of Sidenreng lake exceeds the threshold set by the Minister of Environment and US-EPA (1973). This can be caused by the use of fertilizers on agricultural land. As the condition of Sidenreng lake in some areas, such as in Teteaji village, Sidenreng lake is directly adjacent to the agricultural land of the community around the lake, where in the rainy season, some of the community's agricultural land is submerged in the lake water due to the overflow of lake water. Not all fertilizer particulates that enter the soil will be absorbed by plants as a food source, some of which are stored in the soil and at any time can enter the water column and can result in an increase in nitrate levels in the water (Putri et al. 2019).

Canadian Council of Ministers of the Environment (2008), states that natural waters generally contain nitrite of 0.001 mg/L and should not exceed 0.06 mg/L. The nitrite content in Sidenreng lake water at the first location point is 0.208 ppm and at the second location point 0.402 ppm, it shows that the nitrite content in Sidenreng lake exceeds the threshold set by the Canadian Council of Ministers of the Environment. As we know that nitrite is generally a transitional form between ammonia and nitrate and soon changes to a more stable form, namely nitrate.

The Indonesian Minister of Environment Decree (2004) states that the threshold value of ammonia in the waters is 0.03 mg/L. Ammonia levels in the waters of Lake Sidenreng are 0.0055 ppm at the first point and 0.0063 at the second point. This shows that the value of ammonia in the waters is below the threshold value that has been set.

In conclusion, the nutritional content consisting of crude protein, crude fat and carbohydrate content in the meat of a large (>40 cm) content values were 14.52%, 0.49% and 0.21%, while the crude protein, crude fat and fat content were Carbohydrates contained in the meat of suckermouth catfish which are smaller in size (<22 cm) are 14.58%, 0.52% and 0.09%. Heavy metals Pb, As, Cd and Hg contained in the meat and scales of suckermouth catfish are also below the metal contamination threshold required

based on SNI 2729:2013 so that the fish can be categorized as fish fit for consumption and can be processed into various fishery products with economic value.

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