Macro and Micro Minerals Composition of Indian Scad (Decapterus russelli) From Mollucas Waters

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Abstract. Minerals have a very important role for the human body, fulfillment of mineral needs in humans is obtained by consuming food. One source of animal minerals is Indian scad. Indian scad has a mineral composition that the body needs. This study aims to determine the macro and micro minerals composition of Indian scad. Samples are grouped by body weight, then prepared and tested for macro minerals (Ca, K, Mg and Na) and micro minerals (Cu, Fe, Mn, Se and Zn). The results of grouping the Indian scad based on the average weight obtained by 3 (three) groups, namely group A (72.8 g), B (136.1 g) and C (222.2 g). Proportion of Indian scad has a 69% flesh, 18% head and bones, 13% viscera and gills, 1% blood and water. Macro mineral measurements in each group of fish obtained results: Calcium 40.353 mg/g (A), 37.559 mg/g (B) and 71.334 mg/g (C), Potassium 69.350 mg/g (A), 55.834 mg/g (B) and 67.146 mg/g (C), Magnesium 10.701 mg/g (A), 7.985 mg/g (B) and 11.550 mg/g (C) and Sodium 29.525 mg/g (A), 28.942 mg/g (B) and 29.072 mg/g (C). Micro minerals measurement results: Copper 0.119 mg/g (A), 0.046 mg/g (B) and 0.068 mg/g (C); Iron 0.363 mg/g (A), 0.204 mg/g (B) and 0.324 mg/g (C); Manganese 0.013 mg/g (A), 0.011 mg/g (B) and 0.014 mg/g (C); Selenium 0.464 mg/g (A), 1.007 mg/g (B) and 2.847 mg/g (C); Zinc 0.262 mg/g (A), 0.227 mg/g (B) and 0.431 mg/g (C). Indian scad flesh has a macro and micro minerals composition that varies depending on the body weight of the fish.

1. Introduction
Indian scad is a small pelagic fish resource that plays a major role in the economic sector of fishermen in Ambon City because of its abundant availability and dominates catches by fishermen in Maluku. The marketing volume of fresh Indian scad in Ambon City was 5,122.38 tons with a production value of Rp10,244,760 or $682,984 [1].

Scad fish has a high nutritional content, besides that indian scad flesh also has mineral content [2]. Minerals play an important role in maintaining bodily functions at the cellular, tissue, organ and overall body functions.

Minerals are inorganic elements necessary in the diet for normal body functions. They can be divided into two groups that is macrominerals and microminerals, based on the quantity required in the diet and the amount present in fish. Fish can absorb many minerals directly from the water through their gills and skin, allowing them to compensate to some extent for mineral deficiencies in their diet.

Micro minerals such as iron, zinc, copper, molybdenum, selenium, manganese, cobalt, iodine are needed in very small amounts and are generally found in tissues with very small concentrations [3].

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The presence of minerals in the body of a fish is influenced by several factors, including the size of the fish and the food eaten by the fish. In addition to micro minerals, macro minerals also have an important role for example calcium (Ca) and phosphorus (P) contained in the body functions in the formation of bones and teeth. Lack of calcium can cause osteoporosis \(^4\).

The mineral elements have a very important meaning for various aspects of metabolism in the body. Minerals function to strengthen bones and exoskeleton (outer framework). In addition, minerals also function to maintain the balance of osmotic pressure between body fluids and the nervous system, as well as the surrounding endocrine glands of water. Minerals are also a component of enzymes, blood pigments and other organic compounds. Energy transfer in metabolic processes also involves minerals\(^5\).

The existence of mineral composition in Indian scad of different sizes is important to know because it will determine the nutritional intake of minerals, therefore this study was conducted with the aim to determine the macro and micro mineral composition of the Indian scad flesh in different sizes.

2. Materials and Methods

2.1. Materials and Tools

The raw materials used are Indian scad of various sizes, chemicals used include aquabides, HNO\(_3\), standard solutions for mineral testing. The tools used include Erlenmeyer flask, measuring flask, AAS (Thermo Scientific iCE 3000), destructor (Buchi-Speed Digester K-425).

2.2. Sampling and Sample Preparation Process

Indian scad samples are taken from the catches of fishermen in Maluku waters obtained at the Traditional Market Arumbai in Ambon. The sampling technique uses simple random sampling. Indian scad seller stalls at the market as many as 15 stalls, each stalk sample was taken as many as 2 fish in order to obtain as many as 30 fish samples. Samples are then grouped by weight, each group of fish samples is calculated morphometrically. This research was conducted in two stages, namely the preparation of Indian scad and mineral composition testing. Preparation is carried out with the aim of determining the proportion of each body part of a Indian scad, including separating and weighing the flesh, skin, viscera (including gills), bones and head and blood. Examination of the mineral composition of the Indian scad includes macro minerals (Ca, K, Mg and Na) and micro minerals (Cu, Fe, Mn, Se and Zn).

2.3. Mineral Testing

About 5 g of sample was put into a 250 mL erlenmeyer, added 25 mL of HNO\(_3\) to the erlenmeyer flask and left for 1 hour. Heated the sample in a destructor until it is clear yellow, then cooled. The cooled sample then diluted to 50 mL in a measuring flask, then homogenized and filtered with Whatman paper number 40. Filtered samples are analyzed for minerals using Atomic Absorption Spectrophotometry (AAS). Mineral content in the sample calculated by entering the absorbance value of the sample into the standard line equation \(y = ax \pm b\), then the value \(x\) will be obtained which is the concentration of the sample. Mineral content in the sample can be calculated using the following formula:

\[
\text{Mineral Content (mg g}^{-1}\text{)} = \frac{\text{Mineral Concentration x Dilution Factor}}{\text{Sample Weight (g)}}
\]

3. Results and Discussion

3.1. Proportion of fish body parts

As many as 30 fish were selected through simple random sampling technique collected in one place. Subsequently the samples were grouped into 3 (three), namely Indian scad weighing between 70-75
grams (A), weighing between 125-140 grams (B) and weighing between 170-250 grams (C). The average weight of each sample group can be seen in Table 1.

**Table 1. Indian Scad Sample Group**

| Indian Scad Group | Weight (g)   | Long (cm)   | Wide (cm)   | Correlation Coefficient (r) |
|-------------------|--------------|-------------|-------------|-----------------------------|
| A                 | 72.8±1.383   | 19.6±0.504  | 4±0.001     | 0.9                         |
| B                 | 136.1±5.366  | 23.2±1.020  | 4.5±0.000   | 0.9                         |
| C                 | 222.2±24.681 | 27.5±0.941  | 5±0.001     | 0.9                         |

Table 1 shows that fish group A had an average weight of 72.8 grams with a length of 19.6 cm and a width of 4 cm; fish group B had an average weight of 136.1 grams with a length of 23.2 cm and a width of 4.5 cm; and group C fish with an average weight of 222.2 grams with a length of 27.5 cm and a width of 5 cm. Correlation coefficient (r) relationship of weight and length of Indian scad 0.9. This value indicates that there is a close relationship between weight and length of each group of Indian scad. This means that the increase in body weight of fish affects the length of the fish. If the correlation coefficient 0.90-1.00 shows a very strong correlation \cite{6}. Another thing that can be observed is that the longer the Indian scad does not mean that it will increase its body weight, due to several internal and external factors that influence it. The proportions of each group of Indian scad can be seen in Figures 1, 2 and 3.

![Figure 1. Proportion Group of Indian scad A](image1.png)

**Figure 1. Proportion Group of Indian scad A**

![Figure 2. Proportion Group of Indian scad B](image2.png)

**Figure 2. Proportion Group of Indian scad B**

![Figure 3. Proportion Group of Indian scad C](image3.png)

**Figure 3. Proportion Group of Indian scad C**
Figures 1, 2 and 3 show that the proportion of flesh & skin has the highest proportion of around 68-70% of total body weight, then head & bones around 18-19%, viscera & gills 10-13% and blood & water around 1-2%.

Indian scad have a cigar-like body shape but are slightly flattened, pectoral fins are shorter than the length of the head, the maxilla almost reaches the front of the eye arch, in a fresh state the whole body is pink, and on the back of the gill cover there is a black speck.

The proportion of Indian scad flesh is higher when compared to tuna and cunang fish, respectively by 59% and 55.54% \[7,8\]. Whereas when compared with the Sibero fish flesh that lives in fresh water has a proportion of flesh of 64.19% \[9\]. The proportion of fish body parts varies by type of fish and is dominated by flesh \[10\].

3.2. Macro Mineral Composition

Macro minerals are mineral elements needed in large quantities, which are more than 100 mg a day. The macro mineral group consists of sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), sodium, potassium, sulfur (S) and phosphorus (P) \[11\]. Macro minerals play a role as body building substances, in addition to this mineral also plays a role in maintaining osmotic pressure and acid base balance of the body \[12\]. The presence of minerals in aquatic organisms is generally influenced by the absorption of metals. The ability to absorb metals in these aquatic organisms is influenced by several factors, namely environmental temperature, organism size, species, pH, and starvation conditions of the organism \[13\]. The results of macro mineral measurements on Indian scad can be seen in Figure 4.

**Figure 4.** Macro Mineral Measurement Results of Indian Scad

### 3.2.1. Calcium

The composition of calcium in Indian scad namely 40.353 mg/g (A), 37.559 mg/g (B) and 71.334 mg/g (C). The lowest calcium levels are found in Indian scad that weigh between 125-140 grams (B), while the highest calcium levels are found in Indian scad weighing between 170-250 grams (C). Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of calcium in flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of calcium in Indian scad flesh.

Calcium is needed by the body to regulate cell function and regulate the work of hormones associated with growth factors. The ability of calcium absorption in the body is higher during growth.
and decreases in the aging process \[14\]. Indian scad weighing 170-250 grams (C) are Indian scad that are in their infancy, absorbing more calcium.

3.2.2. Potassium. Potassium concentrations in Indian scad were 69.350 mg / g (A), 55.834 mg / g (B) and 67.146 mg / g (C), respectively. The highest potassium levels are in the group of fish with code A which has a weight between 70-75 grams. Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of potassium in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of mineral content of potassium in Indian scad flesh.

Potassium in cells functions as a catalyst in many biological reactions, especially in energy metabolism and synthesis of glycogen and protein. Potassium plays a role in cell growth. The level of potassium in muscles is related to muscle mass and glycogen stores \[14\]. Indian scad weighing between 70-75 grams (A) having a younger age require more potassium intake for the process of muscle formation than Indian scad weighing 125-140 grams (B) and 170-250 grams (C), for substance synthesis food, and for the body’s energy metabolism, because it is in a growth phase.

3.2.3. Magnesium. Magnesium is an activator of the enzyme peptidase and alin enzyme that functions to break down and move the phosphate group. Magnesium is absorbed in the small intestine and it is thought that only one third of the digestible is absorbed \[14\]. Magnesium concentrations in Indian scad were 10.701 mg / g (A), 7.985 mg / g (B) and 11.550 mg / g (C). The highest levels are in Indian scad weighing between 170-250 grams (C) and the lowest in weighing between 125-140 grams (B). Analysis of variance at 95% confidence interval showed a significant difference between the weight of Indian scad and the amount of magnesium in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of mineral content of magnesium in Indian scad flesh.

Magnesium deficiency in fish causes calcinosis in the kidneys, softening of the bones, deterioration of muscle tissue, pyloric epithelial cells, and gill filaments \[15\]. Magnesium deficiency occurs when you don't consume enough protein and energy. Lack of magnesium in humans will result in lack of appetite, growth disturbances, coma, heart failure, and hypomagnesema (deficiency of Mg in the blood) with symptoms of irregular heartbeat, insomnia, muscle weakness, leg spasms, shaking feet and hands \[16\].

3.2.4. Sodium. Sodium concentrations in Indian scad were 29.525 mg / g (A), 28.942 mg / g (B) and 29.027 mg / g (C), respectively. The highest sodium levels are found in fish groups weighing between 70-75 grams (A). Analysis of variance at 95% confidence interval showed a significant difference between the weight of Indian scad and the amount of sodium in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of mineral content of sodium in Indian scad flesh.

Sodium is mostly found in blood plasma and extracellular fluid, some of which are also present in bones. The highest sodium content found in fish weighing between 70-75 grams is thought to be caused because the fish is in the growth phase, so it requires a higher amount of sodium to support its growth because in the growth phase the proportion of extracellular fluid is higher when the cell is dividing or multiplying \[14\].

3.3. Micro Mineral Composition

Micro minerals are mineral elements in the human body that are needed in small amounts. Micro minerals needed by the body in amounts less than 100 mg / day. The micro mineral group consists of iron, zinc, copper, selenium, iodine, manganese, zinc, cobalt, and fluoride \[11\]. Micro minerals function in the body’s metabolic processes and are part of enzymes, hormones and vitamins \[12\]. The results of macro mineral measurements on Indian scad can be seen in Figure 5.
3.3.1. Copper. Concentrations of copper in Indian scad were 0.119 mg / g (A), 0.046 mg / g (B) and 0.068 mg / g (C), respectively. The highest Copper content is found in Indian scad weighing between 70-75 grams (A). Copper is needed by young fish for the growth process \cite{17}. Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of copper in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of copper in Indian scad flesh. Copper deficiency in fish will cause fish growth to be stunted, growth will be slow and have a dwarf body \cite{18}. Copper plays a role in preventing anemia by helping to absorb iron, stimulate hemoglobin synthesis, release iron deposits from ferritin in the liver, and as part of the enzyme ceruloplasmin. Copper complex has potential as an antimicrobial, antiviral, antiinflammatory, antitumor, enzyme inhibitor or chemical nucleas\cite{19}.

3.3.2. Iron. Iron is a micro mineral that is most abundant in the human body. Iron is classified as an essential nutrient, so it must be supplied from food. Iron concentrations in Indian scad were 0.363 mg / g (A), 0.204 mg / g (B) and 0.324 mg / g (C), respectively. The highest iron content is in the group of fish weighing between 70-75 grams (A), the younger fish need more iron to transport oxygen to tissues (hemoglobin) and cellular oxidation mechanisms, iron is also needed by young fish to support high metabolism in the growth phase \cite{17}. The deficiency of iron can cause stunted growth in fish \cite{20}. Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of iron in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of iron in Indian scad flesh.

The difference in iron content is caused by age, time of arrest, and habitat \cite{21}. Substance iron in the body is needed per day amounting to 15 mg / day is very little but important to note for body needs, the effect of deficiency iron, including anemia. Deficiency iron causes the most anemia common in humans.

3.3.3. Zinc. Zinc concentrations in Indian scad were 0.262 mg / g (A), 0.227 mg / g (B) and 0.431 mg / g (C), respectively. The highest iron content is in the group of fish weighing between 170-250 grams (C) and the lowest in weighing between 125-140 grams (B). Zinc has an important role in protein synthesis and cell division. Fiber and phytic acid contained in food inhibits the availability of zinc in
the body. Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of zinc in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of zinc in Indian scad flesh.

Deficiency zinc in fish can cause slow growth, high mortality, erosion of the fins and skin, dwarf, and loss of appetite [20]. Zinc deficiency in humans will cause short body characteristics and delay in sexual maturation, anemia, disturbed wound healing, and geophagia (impaired taste or abnormal taste) [17, 22]. A good food source for zinc production is fishery products.

3.3.4. Manganese. Manganese concentrations in Indian scad were 0.013 mg / g (A), 0.011 mg / g (B) and 0.014 mg / g (C), respectively. The highest manganese content is in the group of fish weighing between 170-250 grams (C) and the lowest in weighing between 125-140 grams (B). For freshwater fish obtained higher yields, around 0.06-1.08 mg / g [14]. Fish can absorb many minerals directly from the water through their gills and skin, because of its accumulative nature, fish that have an older age automatically have a greater accumulation of minerals than the younger. Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of manganese in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of manganese in Indian scad flesh.

Manganese together with zinc plays a role in bone formation, in vertebrates, manganese is essential for the development of bone and cartilage matrix which is mostly composed of mucopolysaccharides. Micromineral manganese deficiency can cause slow growth, impaired bone growth and can cause cataract in the eye lens in fish, skeletal abnormalities and high embryo mortality at the time of hatching [23, 24].

Manganese deficiency can cause a wide range of problems, including impaired growth, skeletal defects, reduced fertility, birth defects, abnormal glucose tolerance, and altered lipid and carbohydrate metabolism. However, these effects were observed in lab animals and this deficiency is not clinically recognized in humans [25].

3.3.5. Selenium. Selenium concentrations in Indian scad were 0.464 mg / g (A), 1.007 mg / g (B) and 2.847 mg / g (C), respectively. The highest levels of selenium are found in fish groups weighing between 170-250 grams (C), this proves that the larger the fish, the higher the mineral content in the fish's body, this is related to the mineral properties that accumulate in the body. Analysis of variance at a 95% confidence interval showed that there was a significant difference between the weight of Indian scad and the amount of selenium in fish flesh (F count > F table). Duncan’s further test results showed a significant effect between body weight and the amount of selenium in Indian scad flesh.

Selenium is an antioxidant that increases immune function. Selenium is needed in small amounts, but it is important for the body. Selenium is a micro mineral which is an essential part of the enzyme glutathione peroxidase. Selenium is a constituent element of the defense system that protects living organisms from the danger of free radicals. Organic selenium is absorbed more thoroughly and more efficiently than inorganic selenium. Inorganic selenium acts more as a pro-oxidant which triggers glutathione oxidation and oxidative damage to DNA [26].

4. Conclusion
Indian scad flesh has a macro and micro mineral composition, the mineral composition of the Indian scad varies depending on the body weight of the fish.

References
[1] Statistics of Ambon Municipality 2020 Ambon Municipality in Figures (Ambon: BPS-Statistics of Ambon Municipality).
[2] Hadinoto S, and Kolanus J P M 2017 Evaluation of Nutritional Value and Quality of Round Scad (Decapterus sp) Presto With Additional Liquid Smoke and Yeast. Journal of Biam, 13(1): 22-30.

[3] Arfin Z 2008 Some Micro Essential Mineral Elements in Biological Systems and their Analysis Methods. Journal of Agricultural Research and Development, 27(3): 99-105.

[4] Bogden J D, and Klevay L M 2000 Clinical Nutritional of the Essential Trace Elements and Minerals: The Guide for Health Professionals (New York: Springer Science+Business Media, LLC).

[5] Syahril, Soekendarisi E, and Hasyim Z 2016 Comparison of Nutrien Substances of Tilapia Fish (Oreochromis mossambica) From Hasanuddin Lake, Makassar University and Mawang Lake, Gowa South Sulawesi. Bioma, 1(1): 1-7.

[6] Sangadji, M 2016 The Relationship of Length-Weight and Condition Factors for Shortfin Scad (Decapterus macrostoma Blecker, 1851) in the Southern Coast of Haruku Island, Central Maluku. Agribusiness and Fisheries Scientific Journal, 9(2): 24-29.

[7] Hadinoto S, and Idrus S 2018 Proportion and Proximate Analysis Parts of Body Yellowfin Tuna (Thunnus albacares) From Mollucas Waters. Journal of Biam, 14(2): 51-57.

[8] Kartika I W D, and Trilaksani W 2016 Characterization of Collagen from Swim Bladder Waste of Yellow-pike (Muraenesox talabon) by Acid and Hydrothermal Extraction. Indonesian Fisheries Processing Journal, 19(1): 222-232.

[9] Lubis A F, and Syaputra A 2019 Proportion and Proximate Levels of Parts Body Sibero Fish as Raw Materials in the Production of Fishery Food Products. The 3rd Proceedings of National Seminar Multidisciplinary Science of Asahani University August 29, 2019. pp 761-768.

[10] Suwandi R, Nurjannah, and Winem M 2014 Body Parts Proportion and Proximate Levels of Snakehead on Various Sizes. Indonesian Fisheries Processing Journal, 17(1): 22-28.

[11] Nabrzyski M 2007 Functional role of some minerals in foods. In: Szefer P, Nriagu JO (eds) Mineral components in foods, 1st edn (New York: CRC Press).

[12] Biziuk M, and Kuczynska J 2007 Mineral Components in Food - Analytical Implications, In: Mineral Components in Foods, Szefer P. And Nriagu J.O. (Eds), (Boca Raton, FL: Taylor & Francis Group).

[13] Hafidz R, Pagoray H, and Udayana D 2015 Heavy Metal Content of Fe and Mn in Fish Cultures in Post Coal Mining Pond at Kutai Kartanegara Regency, East Kalimantan. Tropical Fisheries Science Journal, 21(1): 61-68.

[14] Mogobe O, Mosepele K, and Masamba W R L 2015 Essential Mineral Content of Common Fish Species in Chanoga, Okavango Delta, Botswana. African Journal of Food Science, 9(9): 480-486.

[15] Halver J E 1989 Fish Nutrition. (New York, Boston: Academic Press).

[16] Al-Ghamdi S M, Cameron E C, Sutton R A 1994 Magnesium Deficiency : Pathophysiologic and Clinical Overview. Am J Kid Dis, 24(5): 737-752.

[17] Nurhayati T, Nurjanah, and Zamzami A H 2014 The Composition of Micro Minerals and Heavy Metal on Milkfish Harvested from Tanjung Pasir Fishpond of Tangerang District. Depik, 3(3): 234-240.

[18] Santosso, W 2009 Macro and micro mineral composition of gouramy (Osphronemus gouramy) at various maintenance times. [Essay]. Faculty of Fisheries and Marine Sciences, Bogor Agricultural University. Bogor.

[19] Iakovidis I, Delimarisi I, and Piperakis S M 2011 Copper and its complexes inmedicine: a biochemical approach. Molecular Biology International, 2011: 1-13.

[20] Wiramiharja Y, Hernawati R, Harahap I M, and Yukiyasu N 2007 Nutrition and Feed Ingredients for Cultivated Fish (Jambi: Freshwater Fish Cultivation Center).

[21] Laurencio H M, Anacleto P, Afonso, Ferraria V, Martins M F, Carvalho M L, Lino A R, and Nunes M L 2009 Elemental Composition of Cephalopods From Portuguese Continental Waters. Food Chemistry, 113(4):1146- 1153.
[22] Nurjanah, Zulhansyah, and Kustiyariyah 2005 Mineral and proximate content of blood clams (*Anadara granosa*) taken from Boalemo Regency, Gorontalo. *Fishery Product Technology, 8*(2): 15-24.

[23] Satoh S, Takeuchi T, and Watanabe T 1987 Availability to carp of manganese in whilefishmeal and various manganese compounds. *Nippon Suisan Gakkaishi, 53*: 825–832.

[24] Lall S P, and Lewis L M 2007 Role of nutrients in skeletal metabolism and pathology in fish. *Aquaculture, 267*(1-4): 3-19.

[25] Dobson A W, Erikson K M, and Aschner M 2004 Manganese Neurotoxicity. *Annals of the New York Academy of Sciences, 1012*: 115-129.

[26] Wycherly B J, Moak M, and Christensen M J 2004 High Dietary Intake of Sodium Selenite Induces Oxidative DNA Damage in Rat Liver. *Nutritional and Cancer, 48*(1): 78-83.