Jurnal Biodjati 7(1):154–162, May 2022

e-ISSN : 2541-4208
p-ISSN : 2548-1606

JURNAL BIODJATI

http://journal.uinsgd.ac.id/index.php/biodjati

Comparative Analysis of Nutritional Content of Mudskipper *Periophthalmus variabilis* and *Boleophthalmus boddarti*

Saifullah Hidayat[1*], Andi Muhammad Yusuf[2], Hamdan Hadi Kusuma[3]

Received: January 25, 2022
Revise from: February 03, 2022
Accepted: April 30, 2022

DOI: 10.15575/biodjati.v7i1.15604

[1,2]Departement of Biology Education, Faculty of Science and Technology, UIN Walisongo, Jl. Walisongo No. 3-5, Semarang City, Central Java, Indonesia, 50185, [3]Departement of Physics Education, Faculty of Science and Technology, UIN Walisongo, Jl. Walisongo No. 3-5, Semarang City Central Java, Indonesia, 50185.

e-mail:
*[1]*hidayatsaifullah@walisongo.ac.id*
[2]*andimuhamady5@gmail.com,*
[3]*hamdanhk@walisongo.ac.id*

**Corresponding author*

Abstract. *Gelodok or mudskipper fish are unique fish that have the ability to live in both aquatic and terrestrial areas. Some Indonesian who live in coastal areas use this fish for consumption. Types of mudskipper that are abundant in Indonesia are from the genera of Boleophtalmus, Periophthalmodon and Periophthalmus, where not all types have been studied for their nutritional content. The aim of this study was to analyze the content of Boleophthalmus boddarti and Periophthalmus variabilis. his study compared the nutritional content of the two types sampled from the Kaliwungu Kendal mangrove ecosystem and the Wedarijaksa Pati mangrove ecosystem. The two types of fish sampled were measured by morphometry which included body length, body width and body weight. Then the fish were analyzed for their nutritional content, namely carbohydrates using the Luff Schroorl test method, protein using the Kjeldahl method, fat using the Soxhlet method, iron using the AAS method, and phosphorus using the spectrophotometer method. The results showed that B. boddarti had a higher protein and iron content than P. variabilis . Meanwhile, P. variabilis had higher carbohydrate, fat and phosphorus content than B. boddarti. The difference was due to different feeding behavior, habitat, and types of food in B.boddarti and P. variabilis.*

Keywords: *Boleophthalmus boddarti, nutritional content, Periophthalmus variabilis.*

Citation

Hidayat, S., Yusuf, A. M. & Kusuma, H. H. (2022). Comparative Analysis of Nutritional Content of Mudskipper *Periophthalmus variabilis* and *Boleophthalmus boddarti*. *Jurnal Biodjati*, 7(1), 36–44.

INTRODUCTION

Mudskipper (Teleostei: Gobiidae: Oxudercinae) is a unique fish that can walk on land (terrestrial) and is able to get out of the water for most of its life. The types of mudskipper that are commonly found in Indonesia are from the genus of *Boleophthalmus, Periophthalmus, and Periophthalmodon* (Hidayat, 2020). These fish are unique because they have the ability to propel their bodies using their pectoral fins (Pace & Gibb, 2009). Moreover, some species are able to climb on steep places such as trees (roots or mangrove trunks) and rocks. Its body is stabilized by using pelvic fins (belly fins), which makes it have a different morphology from other genera (Jaafar et al., 2006). The morphological development of their pelvic fins is perhaps an eco-ethological adaptation to their amphibious lifestyles. With these specific pelvic fins, they can adhere to rocks and exposed roots, and are able to climb the stems of mangroves (Ming-Chih, 2013). Of these, mudskippers from the genus *Periophthalmus* have been studied for their ability to climb. These fish use their pectoral fins an-

Jurnal Biodjati 7(1):154–162, May 2022

JURNAL BIODJATI

http://journal.uinsgd.ac.id/index.php/biodjati

tagonistically with their pelvic fins. The pectoral fins propel the fish forwards while the pelvic fins act as impaction pads that concurrently allow the fish to stick to the climbing surfaces by means of Stefan adhesion (Wicaksono et al., 2016). Two distinct characteristics found in the pelvic fin are the fused shape (the concave shape that does not separate and is attached to the bottom of the body) and the unfused shape (separated leg-like fins that appear under the body and protrude on the other side of the body). Characteristics of pelvic fins from two morphologically different Indonesian mudskipper species, *Boleophthalmus boddarti* (the blue-spotted mudskipper) (Martin, 2013; Chen et al., 2014).

Mudskipper are generally divided into Genus *Boleophthalmus*, Genus *Periophthalmus*, Genus *Periophthalmodon* and *Scartelaos* that live in Indonesia. Based on observations made in the village community of Sambilawang – Trangkil – Pati, it was found that the mudskipper type *Boleophtahlmus boddarti* is fish that is consumed as a daily side dish. The processed forms are smoked or grilled, and used as a side dish. Gelodok fish live wild with a high abundance of gelodok genus Boleophthalmus boddarti found in mangrove ecosystem area in Pati. While the type *Periophthalmus variabilis* is generally not consumed because it is small in size, difficult to catch and there has been no research on its nutritional content. *Periophthalmus variabilis* lives under mangrove trees, mostly on the ground (mainland) and moves actively such as jumping and climbing to mangrove roots so that people find it difficult to catch. According to research by Jignesh Kanejiya et al. (2017) that *Boleophtlamus dussumeiri* fish has a high fat content in the liver (554.45 ± 4.49 mg / g) and muscle (138.70 ± 4.81 mg / g), mineral content of 1.7 ± 0.40 mg / 100mg in liver and of 0.050 ± 0.04 mg / 100mg in muscle, as well as protein content of 3.5 ± 0,35 mg / 100mg in liver and of 1.5 ± 0.47 mg / 100mg in muscle.

The content of protein, fat and carbohydrates in the liver and muscles of mudskipper *Boleophthalmus dussumeri* has been studied previously by Jignesh Kanjiya et al. (2017), Purwasih (2017) and Prasetio et al. (2017). However, no research has been found on the comparison of nutritional content in *Boleophthalmus boddarti* and *Periohthalmus variabilis*. Therefore, the aim of this study was to analyze the comparison of the nutritional content between *Periophthalmus variabilis* and *Boleophthalmus boddarti*. Information regarding this issue can be a solution to solve the problem of lack of nutrition where The problem of stunting or growth failure in children is still a fundamental problem in Indonesia's human development.' Based on data from the Indonesian Toddler Nutritional Status Study (SSGBI), the 2019 the prevalence of stunting was 27.7%. World Bank data for 2020 shows that the prevalence of stunting in Indonesia at 115th out of 151 countries in the world.

MATERIALS AND METHODS

Sampling was carried out on the mangrove coast of Kaliwungu in Kendal and Wedarijaksa, Pati, Central Java. Sample analysis was carried out at the Biology Laboratory, Universitas Islam Negeri Walisongo and Pharmacy College Laboratory, Semarang. The study was carried out in May – September 2021.

Jurnal Biodjati 7(1):154–162, May 2022

JURNAL BIODJATI

http://journal.uinsgd.ac.id/index.php/biodjati

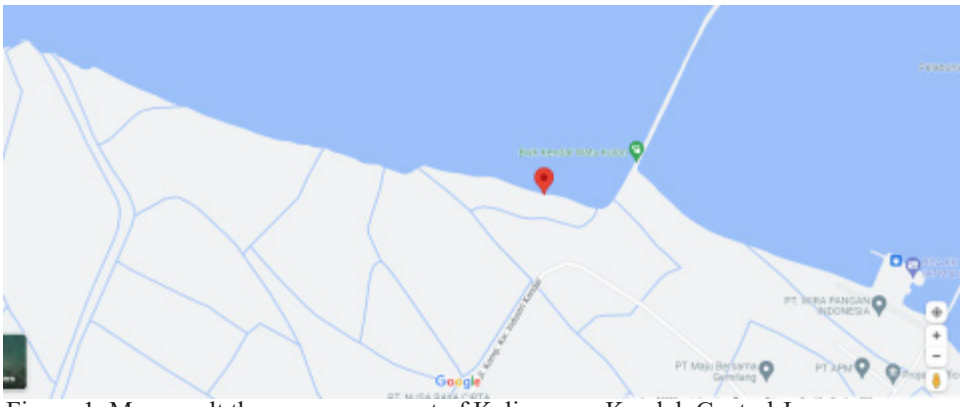

Figure 1. Map result the mangrove coast of Kaliwungu, Kendal, Central Java

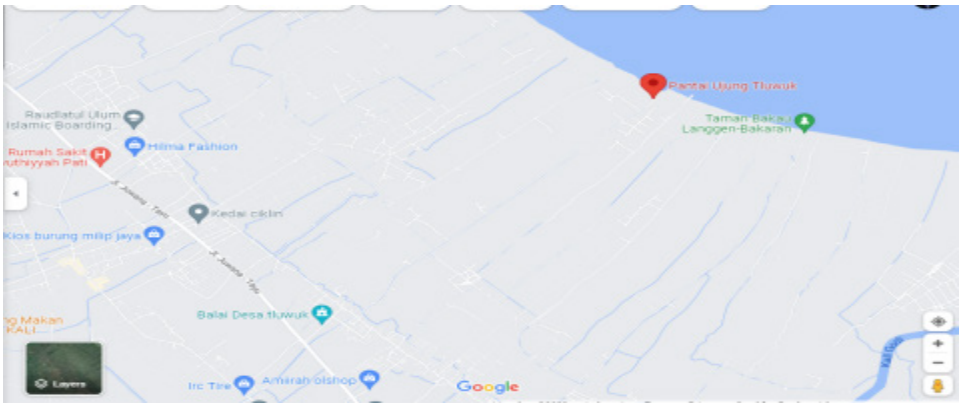

Figure 1. Map result the mangrove coast of Wedarijaksa, Pati, Central Java

The samples used were *Periophthalmus variabilis* and of *Boleophthalmus boddarti* found on the mangrove coast of Kaliwungu and Wedarijaksa with an accidental sampling technique. Each specimen caught using a fishnet and handled with care, then was kept in a separate, aerated aquarium. Adult fish were collected based on their availability during all collection periods. Sampling was carried out 2 times. Fish underside geometries were characterized, by direct measurement and by using a segmented measuring grid placed under each fish. A total of 6 fish from each species were physically characterized with respect to body length, width, and weight. Each fish was then euthanized with 70% ethanol.

Data collection techniques in *P. variabilis* and *B.boddarti* were carried out by observation and research in the laboratory with the following procedures:

Fish preparation

This stage includes sample identification, sample preparation, and morphometric measurement. Identification of mudskipper according to Polgar (2012).

Nutritional Test

Six fish from each species were tested for carbohydrates (Luff Schroorl test), fat (Soxhlet method), protein (Kjeldhal method), iron minerals, (AAS method (Atom Absorbance Spectrometry)), and phosphorus (UV-Vis spectrophotometer method) according to Association guidelines of Official Analytical Chemist (AOAC) in 2005.

Jurnal Biodjati 7(1):154–162, May 2022

JURNAL BIODJATI

http://journal.uinsgd.ac.id/index.php/biodjati

RESULTS AND DISCUSSION

Boleophthalmus boddarti has a larger size than *Periophthalmus variabilis* seen from the length, width, and body weight (figure 1 and 2). *B. boddarti* in Pati had an average body length of 17.4 cm and a weight of 42.5 g (Table 1). While *B. boddarti* fish in Kendal had an average body length of 12.8 cm and a weight of 17.8 g. Meanwhile, *P. variabilis* fish in Pati had an average body length of 6.8 cm and a weight of 2.2 g. *P. variabilis* in Kendal had an average body length of 6.2 cm and a weight of 1.36 g. Research conducted by Shirani et al. (2012) stated that the condition (body size) of fish in polluted areas is smaller than fish found in unpolluted areas. This might be related to the limitation of food sources in polluted area or some stressors that cause loss of appetite in fish, although these somatic factors are not absolutely reliable because they might have been affected by some other factors such as season, diseases, etcetera. According to Hildebrand (1995) the size of an organism affects its function and body shape. And the functions of the body depend on the ratio of the surface to the volume of the body. An organism that has the same function basically also has the same body ratio (geometric similarity) even though the body size is different.

Figure 1. *Boleophthalmus boddarti*

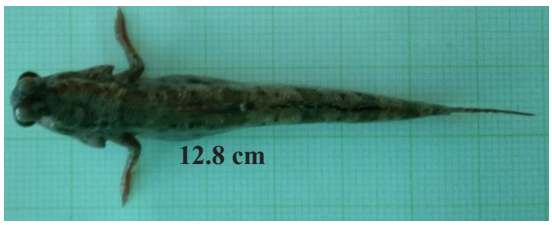

Figure 2. *Boleophthalmus boddarti*

Table 2. Length, wide, and weight of 12 mudskipper

Parameter	BD 1			BD 2			PV 3			PV 4		
	1	2	3	1	2	3	1	2	3	1	2	3
Length	18.5	17.5	16.2	12.4	13.6	12.5	7.9	7.1	5.5	6.1	6.5	6.1
Wide	2.8	2.7	2.5	2.0	2.4	2.0	1.0	0.7	0.7	0.8	0.8	0.8
Weight	49.5	42.5	35.7	15.5	20.5	17.5	3.0	2.7	1.0	1.0	1.8	1.3

Description : BD 1: *B. boddarti* (Pati), BD 2: *B. boddarti* (Kendal), PV 3, *P. variabilis* (Pati), PV 4: *P. variabilis* (Kendal)

Carbohydrate Content

The results on the carbohydrate content of *Boleophthalmus boddarti* and *Periophthalmus variabilis* are presented in figure 3. The result shows that *P. variabilis* has higher carbohydrate content (1.27%) than to *B. boddarti* (0. 91%). The high carbohydrate content in *P. variabilis* can be caused by physiological factors in the fish body and environmental factors such as the amount of food available in the waters (Ramlah et al., 2016). In the Kendal and Pati mangrove ecosystems, there are many small crustaceans that become food for *P. variabilis*.

P. variabilis is adaptive and frequently eat all the food available. According to Gordon et al. (1985), most members of *Periophthalmus* are classified as carnivores, which prey on fish and insects in intertidal areas. while *B. boddarti* eats algae and moss as it is a herbivorous fish. Carbohydrates that enter the fish body will be digested with the help of the amylase enzyme into simple glucose. Digestion of carbohydrates begins in the mouth and ends in the small intestine. The end result of carbohydrate digestion is glucose which will be absorbed by the walls of the small intestine and circulated through the blood system to all organs of the body. Furthermore, glucose is stored in the form of stored glucose or glycogen (Afrianto & Evi, 2005).

Protein Content

Based on the results, the protein content of *B. boddarti* (20.15%) is higher than that of *P. variabilis* (20.11%). The high protein content found in *B. boddarti* could be caused by the higher amount of food compared to *P. variabilis* (Kanejiya et al. 2017). *B. boddarti* belongs to a group of herbivores that feed on algae in the water and mud. This is in accordance with Ravi (2013) who stated that members of the genus *Boleophthalmus* are herbivores that eat algae and diatoms on the surface of the mud by moving their heads. *B. boddarti* out of the hole into the aquatic area to soak in the water and find food in the mud area. This fish often moves along the mud area with the help of its pectoral fins to swing as the function of the forelimbs in tetrapods and uses the pelvic fins as a support for its body. This fish looks for food by turning its head from right to left while opening its mouth. *B. boddarti* belongs to a group of herbivores that feed on algae in the water and mud areas. This is in accordance with research by Ravi (2013) that members of the genus *Boleophthalmus* are herbivores that eat algae and diatoms on the surface of the mud by moving their heads. Nearly 50% of the food found in its stomach is diatoms. When the temperature starts to get hot, these fish go back to soak and swim in the water. In the afternoon *B. boddarti* returned to its activities in the mud area and when it was getting dark the fish returned to their nest.

Fat Content

The results showed that the fat content of *P. variabilis* (3.51%) is higher than that of *B. boddarti* (1.02%). The high fat content in *P. variabilis* can be caused by physiological factors in the fish body and environmental factors such as the amount of food available in the waters (Ramlah et al., 2016). Fish food in nature comes from animals and plants. In the Kendal and Pati mangrove ecosystems, there are many small crustaceans that become food for *P. variabilis*. Food that enters the fish intestine will stimulate the release of cholecystokinin hormone which then stimulate the release of bile to dissolve fat granules into an emulsion, makes it easier to dissolve and absorbed by the intestinal wall and pancreatic juice which contains lipase enzymes (Ramlah et al., 2016). Lipase enzymes can break down fats into fatty acids and glycerol (Ramlah et al., 2016). In the digestive system of fish, the activity of the lipase enzyme is strongly influenced by the levels of protein contained in fish food. In the lining of the intestinal wall, fatty acids and glycerol bind and are then circulated throughout the body through lymph vessels and blood vessels (Djarijah, 1996).

Iron Content

The result in figure 3 shows that the iron content of *B. boddarti* (0.42%) is higher than that of *P. variabilis* (0.20%) . The high iron content found in *B. boddarti* fish can be caused by the higher amount of food available

Jurnal Biodjati 7(1):154–162, May 2022

JURNAL BIODJATI

http://journal.uinsgd.ac.id/index.php/biodjati

compared to *P. variabilis*. *B. boddarti* is out of the hole, swims into the aquatic area to soak in the water and find food in the mud area. The mud area at the research sites contain a lot of algae and moss as food for *B.boddarti* . This fish often moves along the mud area with the help of its pectoral fins to swing and uses the pelvic fins as a support for its body. This fish looks for food by turning its head from right to left while opening its mouth. *B. boddarti* is herbivore that feed on algae in the water and mud areas. This is in accordance with research by Ravi (2013) that members of the genus *Boleophthalmus* are herbivores that eat algae and diatoms on the surface of the mud by moving their heads.

Phosphorus Content

The results of the phosphorus content in *Boleophthalmus boddarti* and *Periophthalmus variabilis* are presented in figure 3. The phosphorus content of *P. variabilis* (0.47%) is higher than that of *B. boddarti* (0.40%). *P.variabilis* has a higher phosphorus content because it eats crustaceans and small insects that contain lots of phosphorus (Ramlah et al., 2016). According to Zainuddin (2010) Phosphorus is needed in the process of bone mineralization, because 80-90% of bone is composed of P, in addition to Ca and Mg.

Phosphorus is one of the most important minerals in the body. As much as 80% of phosphorus in the body is found in bones and teeth in the form of calcium phosphate crystals. Phosphorus is widely available in ready-to-use foods, especially foods that are high in protein, such as eggs, fish, meat, nuts, wheat, and seeds (Wirakusumah, 2010).

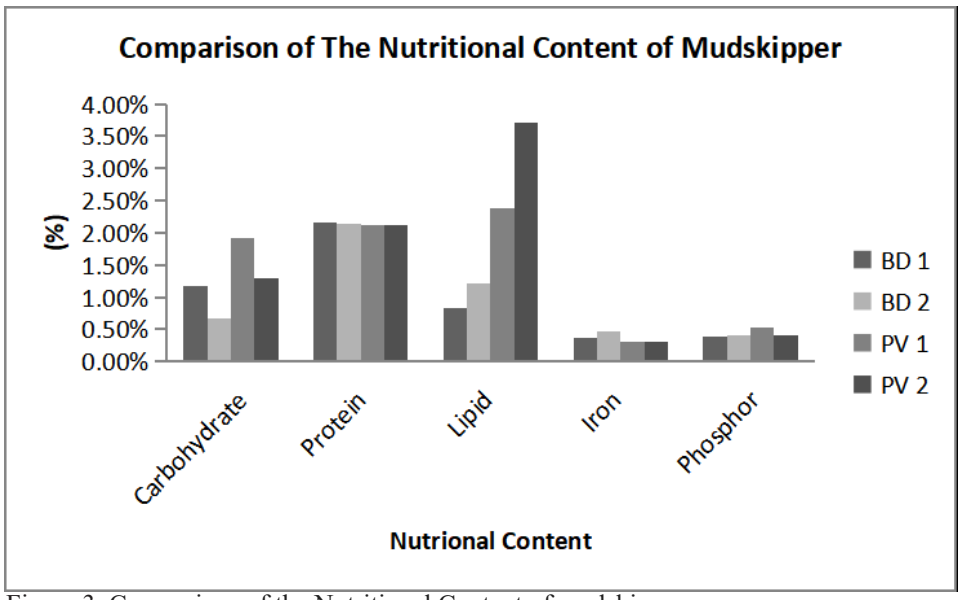

Figure 3. Comparison of the Nutritional Content of mudskipper

The difference in the nutritional content of *Boleophthalmus boddarti* and *Periophtahlmus variabilis* is due to the different activities of the two fish (Hidayat et al., 2022). *Periophthalmus variabilis* and *Boleophthalmus boddarti* as amphibian fish have unique behavior, which is to spend most of their time on land. Based on observations made in both habitats, *P. variabilis* spends more time on wetland (under mangrove) than in water. The observation data carried out for 60minutes showed that *P. variabilis* spent 50 min-

utes (83%) on the land and only 10 minutes (17%) in the water, while *B. boddarti* has the opposite life habits (Hidayat et al., 2022). This behavior is in accordance with Aligaen & Mangao (2011) reported that some of the *Periophthalmus* mudskippers spend most of their lives on land, almost 90% of their lives. Different habitats and activities of fish will affect the type of food to be eaten. *P. variabili*s fish as carnivorous fish while fish *B. boddarti* as herbivorous fish. Different types of food will affect the nutritional content of different fish in the body. According to Thammapat et al. (2010) that the chemical composition of fish is influenced by several factors, including the type of feed, age of the fish, season, and habitat.

Observations also showed some activities of *B. boddarti* at sunset or in the afternoon, this fish entered the hole as a hiding place. While in the morning *B. boddarti* came out of the hole into the aquatic area to soak in the water and find food in the mud area. This fish often moves along the mud area with the help of its pectoral fins to swing which act as forelimbs and uses the pelvic fins as a support for its body. This fish looks for food by turning its head from right to left while opening its mouth. *B. boddarti* belongs to a group of herbivores that feed on algae in water and mud areas.

CONCLUSION

B. boddarti has a higher protein and iron content than *P. variabilis*. Meanwhile, *P. variabilis* had higher carbohydrate, fat and phosphorus content than *B. boddarti*. The difference was due to different feeding behavior, habitat and types of food in *B. boddarti* and *P. variabilis*.

AUTHOR CONTRIBUTION

S.H designed the research and supervised all the process, S.H, A.M.Y and H.H.K collected and analyzed the data. All authors contributed equally in the writing of the article manuscript.

ACKNOWLEDGMENTS

I would like to express my gratitude to those who have assisted in the implementation of this research, especially to the research and community service institutions of UIN Walisongo Semarang who have helped with research costs. Hopefully this research is useful for all parties and the progress of science.

CONFLICT OF INTEREST

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

REFERENCES

Afrianto, E. & E. Liviawaty. (2005). *Pakan Ikan*. Yogyakarta: Kanisius.

Aligaen, J. C. & Mangao, D. D. (2011). *Climate Change Integrated Education: A Model for Life long Learning System*. *A Report*. SEAMEO RECSAM Penang, Malaysia. pp 20.

Association of Official Analitical Chemist. (2005). *Official Method of Analysis of The Association of Official Analytical of Chemist*. Arlington: The Association of Official Analitical Chemist, Inc.

Chen, H., Polgar, G., Yin, W &, Fu, C.Z., (2014). Cryptic Species And Evolutionary Historyof The Boleophthalmus Pectinirostris Complex Along The Northwestern Pacificcoast. *Acta Hydrobiol. Sin*. 38, 75–86.

Djarijah, A. R. (1996). *Pakan Ikan Alami*. Yogyakarta: Kanisius.

Gordon, M. S, Gabaldon, O.J. & Ip, A. Y.W. Y. (1985). Exploratory Observations Of Microhabitat With The Intertidal Zone by the Chinese Mudskipper Fish *Periophthalmus cantonensis*. *Journal of Marine Biology,* 85, 209-215.

Hidayat, S. (2020). *Kajian Ikan Gelodok di Indonesia Bermuatan Unity of Science*. Alinea Media Dipantara.

Hidayat, S., Wicaksono, A., Raharjeng, A., Jin, D. S. M., Alam, P. & Retnoaji, B. (2022). The Morphologies of Mudskipper Pelvic Fins in Relation to Terrestrial and Climbing Behaviour. In Proceedings of the Zoological Society. *Springer,* 1-11).

Jaafar, Z., Lim, K. K.P. & Chou, L.M. (2006). Taxonomical and Morphological Notes Ontwo Species of Mudskippers, Periophthalmus Walailakae and *Priophthalmodon schlosser*i (Teleostei: Gobiidae) from Singapore. *Zool. Sci,* 23, 1043-1047.

Kanejiya, J., Solanki, D. & Gohil, B. (2017). Nutrient Content of Three Species of Mudskipper (Gobiidae; Oxudercinae) In Bhavnagar Coast, Gujarat, India. *Liver*, 2, 2-5.

Martin, K.L. (2013). Theme and Variations: Amphibious Air-Breathing Intertidalfishes. *J. Fish Biol*. 84, 577-602.

Ming-Chih, H. (2013). Mudskippers in Tainan: the Ecology and Lifestyle of Mudskipper *Periophthalmus modestus* in Tainan coastal wetland. Int. *J. Sci. Eng,* 3, 37–43.

Pace, C.M. & Gibb, A. C. (2009). Mudskipper Pectoral Fin Kinematics in Aquatic Andterrestrial Environments. *J. Exp. Biol,* 212, 2279–2286.

Polgar, G., Bartolino, V. (2012). Size variation of Six Species of Oxudercine Gobiesalong The Intertidal Zone in a Malayan Coastal Swamp. *Mar. Ecol. Progr. Ser,* 409, 199–212.

Prasetio, A. O., Nopianti, R., & Herpandi, H. (2017). Profil Asam Lemak dan Asam Amino Ikan Gelodok (Boleophthalmus sculptus). *Disertasi.* Palembang: Universitas Sriwijaya University..

Purwasih, W. (2017). Uji Kandungan Proksimat Ikan Glodok Boleophthalmus Boddarti Pada Kawasan Mangrove di Pantai Ketapang Kota Probolinggo Sebagai Sumber Belajar Biologi. *Disertasi.* Malang: University of Muhammadiyah Malang.

Ramlah, R., Soekendarsi, E., Hasyim, Z. & Hassan, M. S. (2016). Perbandingan Kandungan Gizi Ikan Nila *Oreochromis Niloticus* Asal Danau Mawang Kabupaten Gowa dan Danau Universitas Hasanuddin Kota Makassar. *BIOMA: Jurnal Biologi Makassar,* 1(1), 39-46

Ravi ,V. (2013). Food and Feeding Habits of the mudskipper, Boleophthalmus boddarti (Pallas, 1770) from Pichavaram Mangroves, Southeast Coast of India. *International Journal of Marine Sciences*, (3), 12.

Shirani, M., Mirvaghefi, A., Farahmand, H. & Abdollahi, M. (2012). Biomarker responses in mudskipper (Periophthalmus waltoni) from The Coastal Areas of the Persian Gulf with oil pollution. *Environmental Toxicology and Pharmacology*, 34(3), 705-713.

Thammapa,t P., Raviyan, P. & Siriamorpons. (2010). Proximate and Fatty Acids Composition of Muscles and Viscera of Asian Catfish (Pangasius bocourti). *Food Chemistry,* 122(1), 223-227.

Wicaksono, A., Hidayat, S., Damayanti, Y.,

Jin, D. S. M., Sintya, E., Retnoaji, B. & Alam, P. (2016). The Significance of Pelvic Fin Flexibility For Tree Climbing Fish. *Zoology*, 119(6), 511-517.

Wirakusumah, P. E. 2010. *Cara Sehat Al-Qur'an dan Hadis*. Jakarta Selatan: Hikmah (PT. Mizan Publika).

Zainuddin, Z. (2010). The Effect of Calcium and Phosphorous on Growth, Feed Efficiency, Mineral Content and Body Composition of Brown Marbled Grouper (Epinephelus Fuscoguttatus) Juvenile. *Jurnal Ilmu dan Teknologi Kelautan Tropis*, 2(2), 1-9.