Original Research Article

EPA, DHA, ADG, AND FCR IN BIOFLOC CATFISH FOR IMPROVING THE QUALITY OF THE NUTRIENT WITH FISH OIL ADMINISTRATION

ABSTRACT

This research aims to determine the right dose of fish oil so that it has a good effect on the growth of catfish (Clarias sp.) biofloc as seen from the content of Omega-3 (EPA and DHA), daily average weight gain (ADG) and ratio ratio. feed (FCR). The research was carried out in September and October 2021 at the Ciparanje Green House, Padjadjaran University. The method used is an experimental method using a completely randomized design (CRD) consisting of four treatments with four replications with different levels of fish oil administration, namely 0% (A) as control, 2% (B), 4% (C), and 6%. (D). The fish used is Clarias sp. Fish cultivation from cultivators in Cileunyi village as many as 240 fish weighing 20.04 grams and an average length of 14 cm were randomly placed into 16 fiber tanks based on treatment, while each tank was filled with 15 fish. The size of the fiber tub used was 68 x 68 x 68 cm3 as a cultivation container. The feed given is commercial pellets with the trademark Hi-Provite 781. Fish oil used is fish oil. Parameters observed included omega-3 content, ADG, FCR, and water quality. The results showed that the optimum application of fish oil in increasing the value of EPA content was 36 mg/100g and DHA was 148.5 mg/100 g, the highest ADG value was 0.45%, and the best FCR value was 1.2 and water quality. which is still within the recommended limits in aquaculture using biofloc, provides evidence that the application of fish oil in biofloc aquaculture can improve the nutritional quality of catfish.

Keywords: Catfish, Omega-3, ADG, FCR

1. INTRODUCTION

Aquaculture activities have become an alternative activity for the production of fishery products other than capture fisheries. The increase in aquaculture is increasingly being carried out in Indonesia due to the increasing demand for fishery commodities. In Indonesia, fish is a food requirement that is in great demand. According to [1] Fish contain very good and prospective protein, vitamins, fats and minerals for the human body.

Catfish (Clarias sp.) is one of the fish commodities that are the prima donna of the Indonesian people. This is because catfish has a more affordable price than other fish [2], has a very high protein value [3], has fast growth, and catfish oil which contains relatively high omega-3 fatty acids. higher than other freshwater fish [4]. The content of unsaturated fatty acids and omega-3 fatty acids EPA and DHA in catfish oil is influenced by the age and weight of the fish [5].

Omega-3 fatty acids are fatty acids derived from the essential fatty acid precursors linoleic and linolenic. Omega-3 fatty acids are grouped into essential fatty acids, called essential fatty acids because they cannot be produced by the body, and can be obtained from the food consumed [6]. alpha-linoleic acid (LNA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) [7].

Omega-3 is found in fish oil. Fish oil contains 25% saturated fatty acids and 75% unsaturated fatty acids [1]. Omega-3 fatty acids are mostly found in fish, which contain EPA and DHA . The content of omega-3 fatty acids in fish comes from its food, namely marine microorganisms such as diatomas, dinoflagellates, and chlorella which are plankton. Fish is one of the foodstuffs that have the highest omega-3 fatty acids[8-10]. Omega-3 fatty acids are often found in marine fish such as tuna, salmon, mackerel, and mackerel [2].

The increase in omega-3 fatty acids EPA and DHA in freshwater fish can be done with the addition of fish oil. Several researchers have succeeded in increasing the EPA and DHA content of fish oil by feeding it with omega-3 fatty acids . Giving fish oil with different levels will produce a different fatty acid composition of the fish body. The addition of lemuru fish oil in feed with a concentration of 4-8% can increase -3 fatty acids in fish. The addition of fish oil can be done by mixing it into the feed. Feeding is a source of nutrition for fish being cultivated. The use of feed by fish is strongly influenced by the quality of the feed in terms of nutrient content or the level of digestibility of the feed itself [11-14].

Quality feed in addition to acting as the main energy source is also expected to increase the digestibility of fish so that growth becomes optimum. Feed conversion ratio (FCR) is one indicator to see how much feed can be digested by fish. Research Mardhiana got the highest FCR value at 2.8 and the lowest at 1.7; This shows how optimal the fish's ability to digest and absorb the feed given during maintenance, so that they are able to optimally convert feed into meat. The feed conversion ratio is very influential on body weight and fish growth rate, so it is necessary to also look at the daily average growth (ADG) as an indicator of fish growth. State that growth is an increase in volume and weight over a certain period of time. The daily growth rate is used to calculate the percentage growth of fish weight [14-16].

The use of biofloc systems in fish rearing has many benefits, including efficient use of water, independent of sunlight, higher stocking density (3,000 fish/m3) high productivity, feed efficiency can reach 0.7, efficiency in land use, less waste and friendly. environment. So that fish can develop and grow well. And according to research Faridah, Catfish farming using a biofloc system can reduce mortality, the mortality rate is only 18.75%, and nutrient absorption is 25% [17-19].

Based on this, this study aims to determine the right dose of fish oil so that it has a good effect on the growth of catfish (Clarias sp.) feed conversion ratio (FCR).

2. METHODS

This research was carried out for 4 weeks in September 2021 at the Ciparanje Green House, Padjadjaran University. The research method used was experimental with a completely randomized design (CRD). Then analyzed using descriptive analysis to describe the results of the study..

2.1 Test Feed

Feed had four treatments with different fish oil addition, namely 0% (A) as control, 2% (B), 4% (C), and 6% (D). Feed used was commercial pellet from Hi-Provite 781 brand. Fish oil used was swordfish oil purchased from e-commerce. Fish oil was mixed into feed that has been set by 3% of whole weight in test fish, namely Catfish (*Clarias* sp.) and progol as feed adhesive.

2.2 Pisciculture

Test fish used was *Clarias sp.* fish that was the result of cultivation from the cultivator in Cileunyi village. 240 fishes with weight of 20.04 gram and average length of 14 cm were randomly placed into 16 fiber tubs based on treatment, while every tub was for 15 fishes. Size of the fiber tub used was 68x68x68 cm^3 as breeding container. For installation, blower was used as tool for aeration, heater for regulating temperature to be constant, and aeration hose. Water quality was tested using thermometer to measure water temperature, pH meter was used for measuring pH in water, and Sera Test was used for checking NH_3/NH_4, NO_2 and NO_3 in the breeding media. Tools used in the research were digital scale, scoop, millimeter block, stationary, and documentation tool (mobile phone), ziplock, and label. Fishes were acclimatized first to the environmental condition. Feeding was performed every day at morning (08.00 a.m.) and evening (16.00 p.m.). Fish growth was measured once a week along with the addition of biofloc molasses and paraque once to twice a week.

2.3 Biofloc Making

Procedures for making bioflock were as follows: (1) Preparation of tool and material to be used (e.g., fiber tub and aeration) by cleaning it first, (2) 1 gram of Probiotics from Paraqua brand was directly dissolved into pool, (3) fiber tub that has been ready was filled with 143 litre of water and given aeration, 3 gram of feed and 90 gram of molasses were poured, probiotics were given, and (4) biofloc breeding media was left for 1-5 days. Flock was formed as marked with clot in breeding media [20].

2.4 Observation Parameter

2.4.1 Average Daily Growth (ADG)

Fish test was calculated using the equation formula as stated by [21].

$$ADG = \frac{\text{ABW } 2 \; - ABW \; 1}{t}$$

Where.
ABW 2 = Average weight in second *sampling* or the next (gr/fish)
ABW 1 = Average weight in first *sampling* or previous (gr/fish)
t = Interval of *sampling* (day)

2.4.2 Feed Conversion Ratio (FCR)

According to Tacon, feed conversion ratio formula was as follows [22]:

$$\text{FCR} = \frac{F}{(Wt + D) - Wo}$$

Where.

Wt = Final fish weight (g)
Wo = Initial fish weight (g)
D = Dead fish weight (g)
F = Amount of feed consumed (g)

2.4.3 Omega-3

Omega-3 fatty acid was tested in the Laboratory Saraswanti Indo Genetech using GC method, and descriptively analyzed.

2.4.4 Water Quality

Water quality was tested for its temperature, pH, DO, nitrite, nitrate, and ammonia.

3. RESULTS AND DISCUSSION

3.1 Omega-3

Result of omega-3 fatty acid analysis is shown in Table below.

Table 1. Omega-3 fatty acid in catfish

NO.	Parameter (mg/100g)		
	Treatment	EPA	DHA
1	Fish without adding fish oil	16.7	69.9
2	Fish added with fish oil by 4%	36	148.5

Result above shows that nutrient in catfish with and without treatment of 4% had different levels of omega-3 fatty acid, because of the addition of fish oil in feed at different levels. Treatment without oil only had 16.7 mg/100g of EPA and 69.9 mg/100g of DHA, these values were comparable to the EPA and DHA content of seawater fish, namely Selarides sp. with an EPA value of 17.22 mg. /100 g and the DHA value of 55.48 mg/100 g. Meanwhile, treatment with the addition of fish oil by 4% had 36 mg/100g of EPA and 148.5 mg/100g of DHA, the content values were not much different from Cod which contained 60 mg/100 g of EPA and 120 mg/100 g of DHA. 100 g [23-24]. Result of EPA and DHA in the addition of fish oil by 4% in feed exceeded twice of the result without fish oil.

The ratio of EPA and DHA which is quite large in these fish shows a striking difference between EPA and DHA according to habitat and species. This phenomenon is relatively the same as the research on tuna fish in Bali and North Sulawesi waters. This difference is very possible because the composition of fat and fatty acids in fish is highly dependent on species, habitat, and type of food [25-26].

Omega-3 fatty acid in fish has role that is very important in body. Thus, fish oil is additional substance in feed for growth. Furthermore, fatty acid also plays a role in reproduction, in which successful reproduction is determined by fat as required by the parent and embryo development [27].

The increase of EPA and DHA by twice also improved the nutrient in catfish, while human body can get nutrient from consuming catfish. Nutrient has an important role in the growth and development processes in children and human being of all ages. The lack of omega-3 fatty acid can obstruct physical health, brain growth, vision, and neural problem [7].

3.2 Average Daily Growth (ADG)

Result of Average Daily Growth (ADG) in catfish during the breeding period shows that concentration of fish oil had average weight gain that was different for every treatment. Average weight was approximately between 0.38-0.45%. The highest treatment was treatment C (4%) by 0.45%, while the lowest was in treatment D (6%) by 0.32%. In contrast to the research of Elpawati, which has a specific daily growth of sangkuriang catfish at the age of 7 years with an average range of 3.52 – 10.10%. In this study, the highest daily growth proved that EM10 contained organisms to help increase the specific daily growth value of sangkuriang catfish. Meanwhile, in this study, the addition of 4% fish oil was able to increase the average daily growth value of catfish [28].

Feed given during the experiment has met the primary need of fish for its body and growth. Meanwhile, not all foods in water are used for growth, while most of energy from food is used for breeding, growth, reproduction, and the rest for activities [29-30]

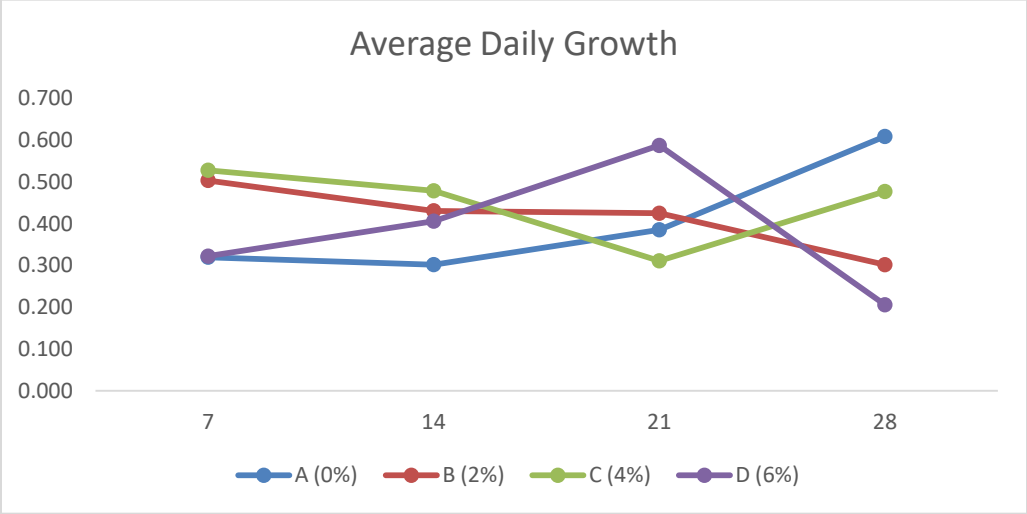

Fig 1.Diagram of Average Daily Growth in Catfish

Weight gain in every treatment was because of fat in artificial feed used as the source of power, thus making growth optimal and weight gain larger . Catfish required 4-5% of fat from feed weight. Excessive administration of fish oil or fat can reduce growth as shown in treatment D (6%). Fat is also a source of energy in fish, while the maximum use of fat in feed can make fish grow faster and result in protein sparing effect. According to Sanjayasari, protein sparing effect can balance the use of fat and carbohydrate for metabolism activities, so body maintenance is not only based on protein [31-33]

3.3 Feed Conversion Ration (FCR)

Feed conversion is comparison between amount of feed given and weight in fish resulted. The use of fish oil at different concentration resulted in various feed conversion ratios. The research shows the result that feed conversion ratio was approximately between 1.20 and 1.40%. The highest feed conversion ratio was in treatment D (6%) at 1.4%. Meanwhile, the lowest efficiency in feeding was in treatment C (4%) at 1.2%. The results of research by Mardhiana, the sangkuriang catfish got the lowest FCR value of 1.7 and the highest 2.8.

The low feed conversion ratio value indicates that the feed given during the study can be utilized optimally by fish into meat, so that it greatly affects the increase in body weight and nutritional content of fish [14].

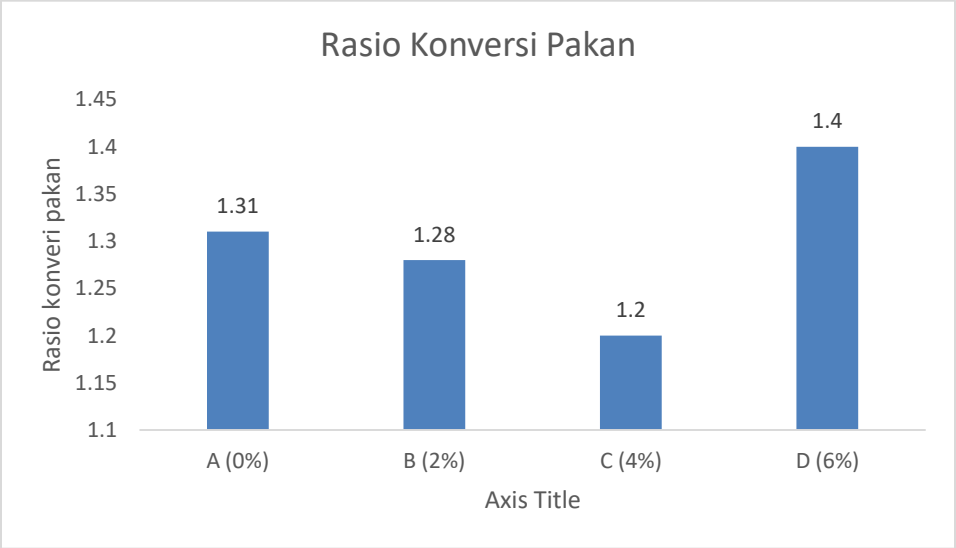

Fig 2. Diagram of Feed Conversion Ratio in Catfish

Feed conversion is affected by feed nutrient absorption in digestive tract. Digestive tract in fishes has microorganism capable of absorbing nutrient. When feed conversion value is lower, efficiency in the feed use will be better. When feed conversion is large, feed efficiency level is less desirable. Thus, feed conversion describes the feed use efficiency achieved. It is supported by a statement from Sulawesty; when the value is lower, it indicates that food can be used in body better and providing larger body weight gain [34-36]

High feed conversion ratio in treatment D (6%) was supposedly caused by excessive fat or fish oil. Excessive fat in feed will cause fat accumulation and heart degeneration in cultivated fish [37]. It shows that feed given with fish oil results in good feed conversion ratio when fish oil concentration is in accordance with the need for nutrient in catfish.

3.4 Water Quality

Water quality is one of the aspects that must be considered in the cultivation since it can affect development and growth in fish. Breeding used the biofloc technology. During the research period, measurement was conducted on parameters of water quality, namely temperature, pH, dissolved oxygen, nitrite, nitrate, and ammonia.

Table 2. Water Quality

Parameter	Unit	Range Value
Temperature	^{o}C	26-30
pH		6.4-6.59
Dissolved Oxygen	mg/L	6.0-6.64
Nitrite	mg/L	0-1
Nitrate	mg/L	0-25

Ammonia	mg/L	0-0.25

Temperature in water is affected by production in cultivation, thus being an environmental factor that must be considered. Water will regulate control of temperature in organism's body [38]. Temperature also affects response of fish consumption to the feed given. The result of measurement on temperature in breeding tub was approximately 26-30^{o}C, while the range was still in the default value according to Indonesian National Standard for catfish that is 25-30 ^{o}C.

Dissolved oxygen is used by all living organisms for respiration, substance exchange, or metabolism process that will produce energy for breeding and growth. Result of measurement on dissolved oxygen during the research period was approximately 6.0-6.64 mg. According to Indonesian National Standard, value of the dissolved oxygen is at least 3 mg/L. Oxygen in the water will increase along with the lowering temperature. On the surface layer, oxygen level will be higher, because of diffusion between water and free air. It shows that need of fish on dissolved oxygen was met during the research [39-40].

Degree of acidity (pH) during the research was approximately between 6.4-6.59, while pH of water in the breeding tub has been suitable for catfish cultivation, with limit of quality standard at 6.5-8 according to Indonesian National Standard. Meanwhile, according Sary, when pH is larger than 9.2 and smaller than 4.8 in water, the water is considered to be polluted [41].

Ammonia during the research period was approximately 0 – 0,25 mg/L. Along with the research by Hermawan dkk [42], ammonia range at 0.071-0.322 mg/L is suitable and adequate for the growth of dumbo catfish. When ammonia concentration in water is high, it will lead to death in fish.

Nitrate value during the research period was between 0-25 mg/l. Low nitrate concentration with the use of biofloc technology indicated that more nitrification bacteria, nitrobacteria in this case, grow th. Meanwhile, nitrite value during the research period was between 0 -1 mg/l, while proper nitrite for fish cultivation was < 1 mg/l. Nitrite value in water at small quantity and unstable condition as a result of oxygen is caused by nitrite of transition from ammonia and nitrate. Nitrite concentration exceeding the limit can be fatal for fish and cause death [42-44].

However, with the same study using catfish, the best temperature for catfish rearing was 27.46°c; the degree of acidity is 6.65 and dissolved oxygen is 3.57 mg/l [45].

4. CONCLUSION

Conclusion that can be made from this research is that the optimum application of fish oil in increasing the value of EPA content was 36 mg/100g and DHA was 148.5 mg/100 g, the highest ADG value was 0.45%, and the best FCR value was 1.2 and water quality. which is still within the recommended limits in aquaculture using biofloc

REFERENCES

[1] Panagan, A. T., H. Yohandini., dan J.U. Gultom. 2011. Qualitative and Quantitative Analysis of Omega-3 Unsaturated Fatty Acid from Catfish Oil (Pangasius pangasius) by Gas Chromatography Method. *Jurnal Penelitian Sains*, *14*(4), 38–42.

[2] Nurasmi., Sari A.P., dan Rusmiati. 2018. Analisis Kandungan Asam Lemak Omega 3, Omega 6 dan Omega 9 Dari Ikan Lele (*Clarias* sp.) Pada Peningkatan Nutrisi Balita. *Journal of Borneo Holistic, Volume 1. No. 1.*
[3] Astawan, M. (2008). *Jeroan bagi kesehatan*. Jakarta: PT. Dian Rakyat.
[4] Suryaningrum, D. 2010. Optimalisasi Pemanfaatan Ikan Lele Dumbo (*Clariaan gariepinus*) dalam Rangka Mendukung Pangan dan Budidaya Perikanan. Jakarta.
[5] Salasah, R., dan Nilawati, M.J. 2016. Kajian Peningkatan Asam Lemak Omega-3 EPA dan DHA Pada Minyak Ikan Lele Yang Diberi Pakan Minyak Kacang Kedelai. *E-Journal Mitra Sains*, *Volume 4 Nomor 2.*
[6] Rasyid Abdullah, 2003. Asam Lemak Omega-3 dari Minyak Ikan*. Jurnal Oseana* XXVIII(3) : 11-16.
[7] Diana, F M. 2012. Omega 3. *Jurnal Kesehatan Masyarakat.* Vol. 6, No.2.
[8] Vilka, F. (2008). *Penetapan kadar asam dokosaheksaenoat (DHA) dan asam eikosapentaenoat (EPA) dalam susu bubuk secara kromatografi gas.* Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Indonesia.
[9] Seto A, H.L. Wang dan C.W.Hessentie.1984. Culture C ondition Affect EPA Content of Chlorella minutissima Journal American Oils Chemistry Society 61;5.
[10] Pratiwy, F. M., dan Pratiwi, D. Y. 2021. Penyuluhan Potensi Omega-3 untuk Meningkatkan Sistem Imun (Terutama Dalam Masa pandemic Covid-19) Secara Virtual. *Farmers: Journal of Community Services*, *2*(1), 30.
[11] Aji, Osie Puspito, 2010. *Kombinasi Tepung Ikan Rucah Pada Pakan Buatan Untuk Meningkatkan Kandungan Omega 3 Ikan Lele Dumbo (Clarias gariepinus Burchell)*. Universitas Atma Jaya, Yogyakarta.
[12] Istiqomah, S., Lamid, M., dan Pursetyo, K. T. 2017. Potensi Penambahan Minyak Ikan Lemuru pada Pakan Komersial terhadap Kandungan Asam Lemak Omega-3 dan Omega-6 Daging Belut Sawah (Monopterus albus). *Jurnal Ilmiah Perikanan Dan Kelautan*, *9*(1), 37.
[13] Rakhfid, A., Mauga, R., Fendi, F., Mosriula M., Wulan, W.S., Bakri, M., Alimin A., & Rochmady R. 2020. Frequencies of feed for growth of Sangkuriang Catfish larvae (*Clarias gariepinus*). *Agrikan: Jurnal Agribisnis Perikanan*, 13(2): 260-268.
[14] Mardhiana, A., Buwono, I.D., Andriani, Y., dan Iskandar. 2017. Suplementasi Probiotik Komersil Pada Pakan Buatan Untuk Induksi Pertumbuhan Ikan Lele Sangkuriang (*Clarias gariepinus*). *Jurnal Perikanan dan Kelautan, Vol. VIII, No. 2.*
[15] Arief, M., Fitriani, N., dan Sri, S. 2014. Pengaruh Pemberian Probiotik Berbeda Pada Pakan Komersial Terhadap Pertumbuhan dan Efisiensi Pakan Ikan Lele Sangkuriang (*Clarias* sp.). *Jurnal Ilmiah Perikanan dan Kelautan*. *Vol. 6, No. 1.*
[16] Handajani dan Widodo, 2010. Nutrisi Ikan. UMM Press. Malang.
[17] Suryadi., Zuriani., Martina., dan Murdani. 2021. Pemanfaatan Lahan Pekarangan Untuk Peningkatan Pendapatan Rumah Tangga Melalui Budidaya Ikan Lele Sistem Bioflok. *Global Science Society : Jurnal Ilmiah Pengabdian Kepada Masyarakat*, *Vol. 3, No. 2.*
[18] Suprapto. 2013. *Budidaya Ikan Lele Dumbo Dengan Menerapkan Teknologi Bioflok.* Klinik IPTEK Mina Bisnis Pacitan. Jawa Timur.
[19] Faridah, F., S. Diana., dan Y. Yuniati. 2019. Budidaya Ikan Lele Dengan Metode Bioflok Pada Peternak Ikan Lele Konvesional. *CARADDE: Jurnal Pengabdian Kepada Masyarakat*, *1*(2), 224–227.
[20] Muzni, M. 2016. Pertumbuhan Ikan Lele (*Clarias gariepinus*) Pada Tingkat Pengurangan Pakan Pada Budidaya Sistem Bioflok di Kabupaten Bandung Indonesia. Skripsi.
[21] Jensen, G. 1992. *Handbook for Common Calculation in Finfish Aquaculture*. LSU AgCenter Research & Extension. England.
[22] Tacon, A. E. J. 1987. The nutrition and Feeding Formed Fish and Shrimp. A training Manual Food and Agriculture of United Nation Brazilling , Brazil. 108 hlm.

[23] Rosli, W., dkk. 2012. Fat Content and EPA and DHA Levels of Selected Marine, Freshwater Fish and Shellfish Species From The East Coast of Peninsular Malaysia. *International Food Research Journal, 19 (3).*
[24] Marangoni, F., dkk. 2016. Material Diet and Nutrient Requirements in Pregnancy and Breastfeeding. An Italian Consensus Document. *Journal Nutrients*, *Vol. 8, No. 629.*
[25] Sunarya, M., Fitriati & Mulyani, H. (1995).The effect of season on fat content and fatty acid profile especilly n-3 Of Yellowfin Tuna.Suplement FAO Fisheries Report No. 514. Food and Agriculture Organization Of The United Nation. Rome P. 205-209.
[26] Ackman, RG. 1982. Fatty Acid Compotition of Fish Oil. Dalam MS Barlow dan ME Stand by. Nutritional Evaluation of Long Chain Fatty Acid in Fish Oil. Academic Press, London
[27] Pangkey, H. 2011. Kebutuhan Asam Lemak Esensial Pada Ikan Laut. *Jurnal Perikanan Dan Kelautan Tropis*, *7*(2), 93.
[28] Elpawati., Pratiwi., D.R., dan Nani, R. 2015. Aplikasi Effective Microorganism 10 (EM_{10}) Untuk Pertumbuhan Ikan Lele Sangkuriang (*Clarias gariepinus* var. Sangkuriang) di Kolam Budidaya Lele Jombang, Tangerang. *Jurnal Biologi, Volume 8 Nomor 1.*
[29] Mukti, R. C., Bambang, N., Utomo, P., dan Affandi, R. 2014. Penambahan minyak ikan pada pakan komersial terhadap pertumbuhan Anguilla bicolor bicolor Fish oil supplementation in commercial diet on growth of Anguilla bicolor bicolor. *Jurnal Akuakultur Indonesia*, *13*(1), 54–60.
[30] Puteri, B J., Subandiyono, Hastuti S. 2020). Peran Kromium (Cr+3) dalam Pakan Buatan Terhadap Tingkat Efisiensi Pemanfaatan Pakan dan Pertumbuhan. *Jurnal Sains Akuakultur Tropis*. 4(2020)2:161-170.
[31] Munisa, Q., Subandiyono, dan Pinandoyo. 2017. Pengaruh Kandungan Lemak dan Energi yang Berbeda dalam Pakan Terhadap Pemanfaatan Pakan dan Pertumbuhan Patin (Pangasius pangasius). *Journal of Aquaculture Management and Technology*, *4*(4), 95–100.
[32] Dinas Ketahanan Pangan dan Perikanan (DKPP). 2018. Membuat Sendiri Pakan Lele Secara Alternatif. https:dkpp.bulelengkab.go.id diakses pada 13 Maret 2022.
[33] Sanjayasari, D., dan Kasprijo. 2010. Estimasi Nisbah Protein-Energi Pakan Ikan Senggaringan (Mystus nigriceps) Dasar Nutrisi untuk Keberhasilan Dokumentasi. *Jurnal Perikanan dan Kelautan*. Jurusan Perikanan dan Kelautan Fakultas Sains dan Teknik. Unsoed Purwokerto. Purwokerto. 15(2): 89-97.
[34] Ardita, N., Budiharjo, A., Lusi, S., dan Sari, A. 2015. Pertumbuhan dan rasio konversi pakan ikan nila (Oreochromis niloticus) dengan penambahan prebiotik. *Bioteknologi*, *12*(1), 16–21.
[35] Iskandar, S., H. Resnawati dan T. Pasaribu, 2000. Growth and Carcass Responses of Three Lines of Local Chickens and its Crossing to Detary Lysine and Methionine. In the Proc. Of the 3rd International Seminar on Tropical Animal Production: Animal Production and Total Management of Local Resources. Faculty of Animal Science - Gadjah Mada University.
[36] Sulawesty, F., Chrismadha, T., & Mulyana, E. (2014). Laju pertumbuhan ikan mas (Cyprinus carpio L) dengan pemberian pakan lemna (Lemna perpusilla Torr.) segar pada kolam sistem aliran tertutup. *Pusat Penelitian Limnologi-LIPI*, *21*(2), 177–184.
[37] Roberts, R.J. 1989. Fish Pathology 2nded. Baillierre Tindall. London
[38] Boyd, C. 2015. *Water Quality. Switzerland.* Springer.
[39] Pariwono. 2005. Oksigen Terlarut (DO) Dan Kebutuhan Oksigen Biologi (BOD) Sebagai Salah Satu Indikator Untuk Menentukan Kualitas Perairan. *Oseana*, *30*(3), 21–26.
[40] Odum, E. P. 1971. *Dasar-Dasar Ekologi.* Edisi kettiga Gadjah Mada University Press. Yogyakarta.
[41] Sary. 2006. *Bahan Kuliah Manajemen Kualitas Air.* Politehnik Vedca. Cianjur.

[42] Hermawan, A T., Iskandar, dan Subhan, U. 2012. Pengaruh Padat Tebar Terhadap Kelangsungan Hidup Pertumbuhan Lele Dumbo (Clarias Gariepinus Burch.) Di Kolam Kali Menir Indramayu. *Jurnal Perikanan Dan Kelautan Unpad*, *3*(3), 85–93.
[43] Wedmeyer, G.A., dan Yasutake, W. T. 1997. *Clinical methods for the assessment of the effects of environmental stress on fish health*. Technical Papers of The U.S. Fish and Wildlife Service. U.S. Depart. of The Interior,.
[44] Effendie, M.I. 2003. *Biologi Perikanan.* Yayasan Pustaka Nusatama. Yogyakarta.
[45] Pujiharsono, H., dan Kurnianto, D. 2020. Sistem Inferensi Fuzzy Mamdani Untuk Menentukan Tingkat Kualitas Air Pada Kolam Bioflok Dalam Budidaya Ikan Lele. *Jurnal Teknologi dan Sistem Komputer*, *8(2).*