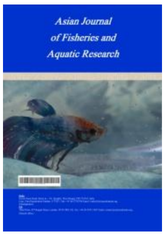

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Increasing Growth Performance and Omega-3 of Pangasius Catfish with Fish Oil Administration

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This research aims to examine the effect of adding fish oil on the growth performance and content of Omega-3 fatty acids in Pangasius catfish (*Pangasius* sp). The research carried out in October and November 2021 at the Faculty of Fisheries, Padjadjaran University. Pangasius catfish with an average weight of 12.41 gram were reared in a fiber tank with stocked with 15 giving a stocking density of 10 $fish^{-1}$ m^2. The fish were reared for 28 days. This study used a completely randomized design with five treatments with fish oil supplemented to the feed at 0%, 3%, 4%, 5%, and 6% with each treatment consisting of three replications. The fish were fed twice a day at 08:00 am and 16:00 pm West Indonesian time, at a feeding level of 3% of the fish biomass per day. The feed used was pellet for catfish from Hi Provite PF 781 brand. Parameter tested included SGR, feed efficiency, omega-3 content and water quality. The result showed optimum application of fish oil increasing growth performance, the highest SGR was 2.07% day^{-1}, the best efficiency feed 85.85%, EPA content was 30.7 mg^{-1} 100 gram and DHA was 10.6 mg^{-1} 100 gram.

Keywords: Pangasius catfish; fish oil; specific growth rate; feed effeciency; omega-3.

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1. INTRODUCTION

Pangasius catfish is a type of freshwater consumption fish that has good prospects because of its high selling value and easy cultivation. Pangasius catfish are classified as omnivores and tend to be carnivores and feeding habits that are influenced by the type and amount of food in the maintenance media or their habitat [1]. Pangasius catfish have benefits as a source of a high supply of animal protein and as an ornamental fish, in 159 gram fillet contains 24.7 gram, with 14.53% protein, 1.03% fat, 0.74% ash, and 82.22% water [2].

Fatty acids are classified based on their structure, carbon-chain length (short, medium, or long), degree of saturation (number of double bonds), and location of double bonds [3]. Classification of the double bond, fatty acids are divided into two parts, namely saturated fatty acids and unsaturated. Omega-3 fatty acids are polyunsaturated fatty acids that have many double bonds and are derivatives of their precursors, namely the essential fatty acids linoleic and linolenic [4]. Essential fatty acids cannot be formed by the body, so they must be supplied from food. The precursor enters the elongation and desaturation process which produces three forms of omega-3 fatty acids, namely LNA/ALA (alpha-linoleic acid (C1:3, n-3)), EPA (eicosapentaenoic acid (C20:5,n-3)), and DHA (docosahexaenoic (C22:6, n-3) [5].

Apart from being used as an energy source, fat also functions as a source of essential fatty acids [6]. Essential fatty acids are fatty acids that cannot be synthesized by the body and come from the fish food source itself, so they need to be added to the feed. Fish oil is a source of essential fatty acids. Fatty acids play an important role in supporting metabolic activities, precursors of several prostanoids, substrates for the formation of lipoxygenase, membrane components, and main precursors for the formation of leukotrienes [7]. Fat can also be used as a protein-sparing *effect* in forming tissue so that the use of protein can be optimized as a source of growth for fish [8].

One of the main components of food that has a positive impact on health is fat that has multifunctionality, namely as the largest energy contributor (30% or more of the total energy needed by the body) and is a source of essential fatty acids linoleic and linolenic [6]. In addition, it is used as an energy source, part of cell membranes, mediator of biological activity between cells, insulator in maintaining the balance of body temperature, protecting body organs and solvents for vitamins A, D, E, and K. Omega-3 unsaturated fatty acids, It plays an important role in the morphological, biochemical, and molecular development of the brain and other organs. The deficiency of omega-3 fatty acids caused by inadequate intake or due to diseases that reduce absorption can inhibit brain development, physical health, and environmental interactions and have a strong effect on the formation of cognitive development [9].

Fish oil can be a source of energy that increases growth and the content of Omega-3 in fish. Growth of Angulia bicolor bicolor increased at the limit of 10% fish oil addition supplementation [10]. Addition of 10% soybean oil mixed with feed in catfish increased growth performance and omega-3 fatty acid levels by 8.33%, EPA content 5.05%, and DHA 1.14% [11]. Omega-3 levels in Monopetrus albus also increased through the addition of lemuru oil at a dose of 4-8% to the feed [12]. The purpose of this study was to improve growth performance and omega-3 content in catfish by adding fish oil to feed.

2. METHODS

This research was carried out for 28 days in October 2021 at the Faculty of Fisheries, Padjadjaran University. The research used was experimental with a Completely Randomized Design (CRD) with 5 treatment and each treatment consisting of three replications.

2.1 Test Feed

Preparation of the test feed was started by mixing the feed with fish oil according to the treatment, namely 0%, 3%, 4%, 5% and 6%. The feed used was pellet for catfish from Hi Provite PF 781 brand. Feed has been set by 3% of whole weight test fish mixed with fish oil was added with 5 g of progol which functions as a feed adhesive and fish oil. Then the feed dried until the fish oil glued and not come off the feed. After the feed dry, the feed is put in a plastic ziplock and stored in a dry place.

Treatment A: Control (without the addition of fish oil), Treatment B: Addition of 3% fish oil, Treatment C: Addition of 4% fish oil, Treatment D: Addition of 5% fish oil, and Treatment E: Addition of 6% fish oil.

2.2 Pisciculture

Test fish used in this study was Pangasius catfish from Purwakarta, West Java. Pangasius catfish sized 9-11 cm with an average weight of 12.41 gram. The fish are adapted to the new environment first and the feed given in a fiber tank with a volume of 450 liters. Then transferred to the rearing container as many as 15 test fish per fiber tub with a volume of 240 liters which had previously been weighed. Feeding performed every day at 08:00 West Indonesian time (morning) and 16:00 West Indonesian time (evening). Siphoning is carried out every day, while water changes are carried out 4 times a day 35% of water with water that has been deposited first. Maintenance was carried out for 28 days of observation. At the beginning and end of rearing several fish samples were taken for proximate analysis and fatty acid omega-3 analysis. Water quality was testing.

2.3 Observation Parameters

2.3.1 Specific growth rate (SGR)

The test fish were calculated using the following equation [13]:

$$\mathrm{SGR} = \frac{\ln Wt - \ln Wo}{t} x\ 100\%$$

Information:

Wt = Average weight of fish at the end of rearing (g)
Wo = Average weight of fish at the beginning of rearing (g)
t = Length of time of rearing

2.3.2 Feed efficiency

The formula used to calculate feed efficiency is [14]:

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

Information:

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

2.3.3 Proximate analysis and omega-3 fatty acids proximate

Proximate analysis of pangasius catfish flesh was carried out at the Laboratory of ruminant nutrition and animal feed chemistry, Faculty of Animal Science, Padjadjaran University. Omega-3 fatty acids were tested using the Gas Chromatography method at the Indo Genetech Laboratory. Measurement of omega-3 using split metode injection, 1.0 µL injection volume, temperature 240ºC, 30 ml/min flow H_2 and 300 ml/min air flow.

The formula used to calculate fatty acid in injection is [15]:

$$\text{Fatty acid in injection} = \frac{Area\ of\ fatty\ acid\ component}{Total\ area\ of\ fatty\ acid\ component}$$

The formula used to calculate fatty acid in sample is [15]:

$$\text{Fatty acid in sample (\%)} = \text{Fatty acid in injection (\%) x Fatty acid level (\%)}$$

The formula used to calculate unsaturated fatty acid level is [15]:

$$\text{Unsaturated fatty acid level (\%)} = \sum \text{Injection unsaturated fatty acid (\%) x Fatty acid level (\%)}$$

2.3.4 Data analysis

Parameters *specific growth rate* (SGR) and feed efficiency were tested used analysis of variance/F test and further tests used Duncan's test to see the effect of treatment on each parameter to be tested, at a 95% confidence level. Water quality parameters were analyzed descriptively.

3. RESULTS AND DISCUSSION

3.1 Specific Growth Rate (SGR)

The biomass data for Pangasius catfish during the study is shown in Fig. 1. Based on these data, each treatment showed a different average increase in biomass. The average initial biomass of Pangasius catfish was 178.48 g – 190.62 g and at the last observation, the biomass reached 294.17 g – 238.89 g. The highest increase in average growth value was in treatment C with an average final biomass of 252.87 g.

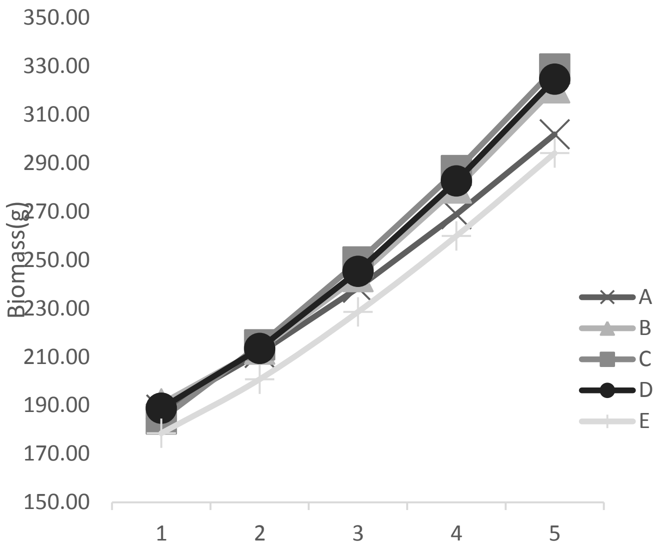

Fig. 1. Diagram of pangasius catfish biomass

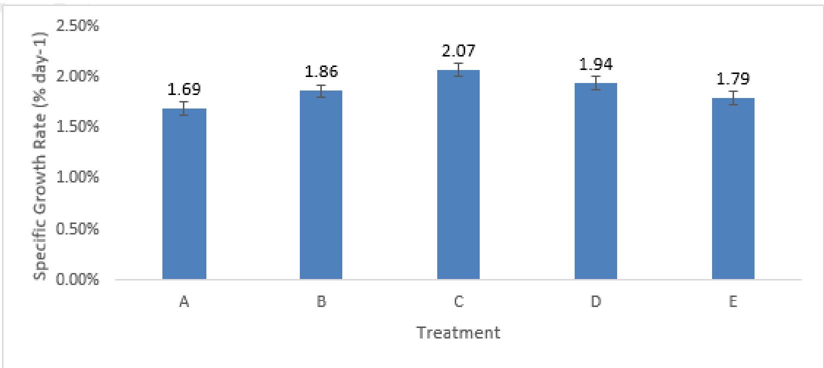

Fig. 2. Diagram of pangasius catfish specific growth rate

The SGR yield of pangasius catfish was still relatively good at>0.72% [16] and the highest yield of 2.11% was comparable to the biomass value obtained during the study. This shows that the application of fish oil to commercial feed is still in a good range for the specific growth rate, where the results obtained are 1.69%-2.07%. The difference in average growth in each treatment was caused by the addition of fish oil which is fat into the feed, causing a larger source of energy to be used in activities such as movement or metabolism, while the energy source from protein can be optimized in the utilization of fish growth. The addition of fish oil increases biomass of Pangasius catfish by 62.12% [17] and increased the growth rate and survival of tilapia [18]. The addition of fish oil to Pangasius catfish feed showed a positive impact on its growth by considering the limit of fish oil content given.

Fat that enters the body becomes one of the energy contributors to support metabolic activities so that most of the protein from feed can be utilized to support growth. However, the high-fat content due to the addition of fish oil causes the activity of lipogenic enzymes to decrease, thereby inhibiting fatty acid synthesis [8]. The high-fat content in the feed will increase the chance of fat peroxidase and affect the sensory attributes of the muscles [19] bureau. This can result in lower growth rates and increased feed conversion. The low-fat content in feed results in less than optimal growth because the fat content in the feed given is only used for body maintenance and replacing damaged cells [17].

3.2 Feed Efficiency

Feed efficiency is the level of utilization of feed provided to support fish growth. The utilization rate is seen from the addition of fish weight and the amount of feed given for a certain time. The feed efficiency of Pangasius catfish during the study was different effect in every treatment, treatment C (85.85% ± 2.91[d]), treatment A (69.66%), treatment B (78.25%± 1.81[c]), treatment D (81.15% ± 0.85[c]) and treatment E (74.12% ± 1.36[b]).

The value of feed efficiency in each treatment during the study was classified as good (69.66%-85.85%), feed can be said to be good if the feed efficiency value is more than 50% or even close to 100% [20]. High feed efficiency indicates optimal feed use so that protein can be used for growth because only a small amount of protein is utilized for energy needs [21]. This supports the results of the specific growth rate of pangasius catfish during maintenance which is classified as good in each treatment.

Treatment with the added fish oil more than 4% showed an increase and decrease in several weeks of rearing, which was directly proportional to the specific growth rate which was smaller than treatment C (4% fish oil). Adaptation of feed with the addition of fish oil was better by pangasius catfish during rearing. Fish oil is not only used as a source of fat but also functions as an attractant. This attractant can cause an odor in the feed so that it makes fish eat it [22]. The difference in feed efficiency values is thought to be due to the digestibility of different feeds. One of the indicators used to assess the level of efficiency of feed given to fish is feed digestibility [23].

3.3 Proximate Analysis and Fatty Acid Omega-3

The following is the result of the proximate analysis of pangasius catfish at the beginning of the study, the treatment without the addition of fish oil, and the addition of 4% fish oil.

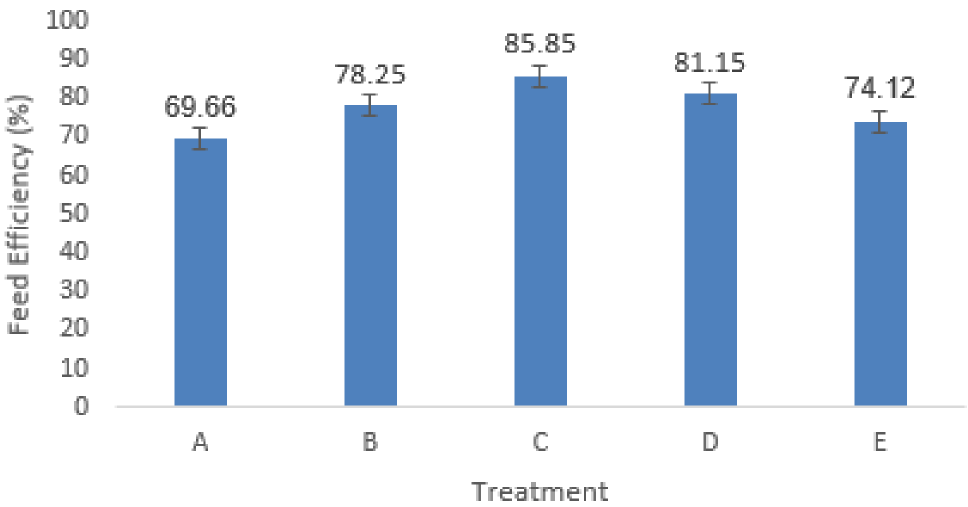

Fig. 3. Diagram of feed efficiency

Table 1. Results of proximate analysis pangasius catfish

Perlakuan	Water %	Ash %	Protein %	Fat %	Carbohydrate %	Gross Energy Kcal/kg
Fish initial	81,90	3.37	18,59	6,10	66,41	3801
Fish without addition fish oil	44,05	5.19	21,13	7,71	67,79	4173
Fish with addition 4% fish oil	34,08	1.97	22,42	9,20	70.12	4333

Fat content in fish at the beginning of rearing, treatment A and treatment C of 6.10%, 7.71% and 9.20. Pangas catfish contain a fat content of 5.49% [24]. The fat content in fish is obtained from the consumption of available feed which is then absorbed or synthesized by the liver. The fat anabolism process goes through several stages, namely the formation of glycerol, the formation of fatty acid molecules and the condensation of fatty acids with glycerol to form fats [25]. Fat catabolism occurs by the breakdown of fats into fatty acids and glycerol. Fatty acids will go through the beta-oxidation process to produce *acetyl* CoA which enters the Krebs cycle and produces energy [26]. Through the process of fat metabolism, higher fat content which is one of the energy sources has the potential to increase the amount of energy in fish. In addition, the results of fatty acids derived from fat in the feed will produce omega-3 which are essential fatty acids in the body.

Pangas catfish contains a water content of 77.43% [27] which indicates that the water content of Pangas catfish in nature contains a high water content equal to the water content of the control treatment. The water content has the opposite relationship with the fat content, namely the higher the water content in the fish, the lower the fat content [28]. The entry of water into the spaces between cells and plasma. Fish with red meat has a low protein content, but a higher water content [29]. White fish meat has a high protein content and low water content. Pangas catfish have a flesh color that tends to be whiter in color compared to other fish that have a higher protein content.

The protein content of the catfish pangas increased from the beginning, the control, and treatment C at the end of the rearing with values of 18.59%, 21.13%, and 22.42%, respectively, when compared to the cultured catfish pangas containing 18.9% protein content while in nature it was 20.2% [30], the results of this study showed that the difference in numbers was not significant but there was an increase in treatment C (4% fish oil). The level of digestibility of each content in the feed source will affect the content of the fish. The level of protein and fat digestibility in fish will be directly proportional, if there is an increase in protein digestibility, there will be an increase in fat digestibility and vice versa [31]. This happens because the fatty acids contained in the fat are used to contribute fish metabolism which can affect protein digestibility. So that the addition of fish oil in feed containing fatty acids has an effect on protein levels in fish, feeding with fatty acid content in Kuwe fish affects protein digestibility [32]. One of the functions of protein, namely as a source of energy, has been fully fulfilled through the existing fat.

Carbohydrates increased in the initial, control, and treatment C fish with values of 66.41%, 67.79%, and 70.12%, respectively, this increase indicates that the pangasius catfish can utilize nutrients in the feed. Carbohydrates and fats have a big role in meeting the needs of fish intake. The increase in carbohydrates was in line with the increase in fat in Pangasius catfish. Carbohydrates will be converted into glucose which is used for energy needs, some will be stored as glycogen in the liver and fish meat and some will be converted into fat and will be stored in fat tissue [33]. The ash content of Pangasius catfish meat during the study was still relatively low. Ash content is influenced by the high and low levels of minerals in fish meat, minerals play an important role in body functions, at every level of cells, tissues, organs, and even the function of the body as a whole [34].

Pangasius catfish have an energy value of 2070 to 2210 Kcal/kg [35]. The increase in energy until the end of rearing indicates the utilization of energy from the feed given. Fat in the body is more likely to be stored in the body as an energy source that is utilized for growth [36] meyer. The feed with fish oil added had a higher energy content than the feed without fish oil added. The higher energy will support the activity of the pangasius catfish, which will be utilized in the process of metabolism, movement, growth, and reproduction. Optimal growth for fish requires an energy of 3320 Kcal so growth and energy utilization in this study are classified as optimal [37].

The effect of adding fish oil to the feed on the levels of EPA and DHA in treatments A and C can be seen in Table 2.

The addition of fish oil showed an increase in EPA levels in treatment C reaching 27.91% and DHA reaching 31.13%. Pangasius catfish contains EPA 8.5-23.8 mg^{-1} gram and DHA 2.55-11.05 mg^{-1} 100 gram [38]. Catfish also experienced an increase in EPA 115.56% and DHA 114.47% with the addition of 4% fish oil to the feed. Feeding a feed with a higher omega-3 content will further increase the omega-3 content in fish, but if the feed is given a lower omega-3

Table 2. Results of analysis of EPA and DHA content of pangasius catfish

Treatment	EPA (mg^{-1} 100 gr)	DHA (mg^{-1} 100 gr)
Fish without addition fish oil	7.3	24
Fish with addition 4% fish oil	10.6	30.7

Table 3. Results of water quality

Parameter	Unit	Range Value
Temperature	^{0}C	23-30
pH	-	7.1-8.2
Dissolved Oxygen	mg/L	5.9-7.5
Ammonia	mg/L	0-0.3

content it will produce higher omega-9 and vice versa [26]. The addition of 5% fish oil to eel increased EPA 0.51 mg^{-1} 100 gram and decreased omega-3 yield with feeding >5% fish oil [28]. The difference in the results obtained is thought to be due to differences in the type of fish, the fish oil used, and the time of maintenance carried out [28].

The process of fat metabolism including omega-3 fatty acids occurs in the liver, especially in the cytoplasm [26]. EPA and DHA anabolism begins with the breakdown of fat from feed into glycerol which will eventually produce palmitate CoA which will synthesize long and short-chain unsaturated fatty acids. The formation of EPA and DHA is assisted by elongase and desaturase enzymes [5]. However, omega-3 fatty acids are essential fatty acids that must be supplied from the given feed source [7]. The addition of fish oil with a high content of unsaturated fatty acids is the main source of ingredients for the formation of EPA and DHA in pangasius catfish.

3.5 Water Quality

Water quality during the study for each treatment is presented in the Table 3. Water quality is one of the factors in the environment of fish living media that affects the survival and growth of fish. Measurement of water quality aims to see if some parameters are still within tolerance and support the growth of good pangasius catfish. The results of water quality measurements in each treatment were relatively the same, this shows that feeding with the addition of fish oil did not change the water quality of the rearing media.

The temperature range of 25-32°C is optimal temperature for supporting growth for tropical aquatic organisms [39]. In most fish species, the metabolic rate above the optimum temperature will increase and energy begins to be diverted from growth to compensate for the high metabolic rate so that the growth rate decreases [40]. The pH content during the study did not change significantly in each treatment and was still in the concentration range that supported the growth of catfish. The pH suitable for the life of the pangasius catfish ranges from 6.5 to 8.0 [41].

Dissolved oxygen content ranged from 6-7.4 mg/L is optimal for fish [42], this content was relatively constant until the end of the study because each maintenance container was equipped with aeration equipment to supply oxygen. The standard dissolved oxygen content for the growth of pangasius catfish is DO 3 mg/L [43]. Ammonia levels during the study were quite low due to regular siphoning and water changes. Ammonia content is toxic at concentration of 0.6-2.0 mg/L [44]. Fish excrete 80-90% of ammonia (N-inorganic) through the process of osmoregulation, while from feces and urine about 10-20% of total nitrogen [45].

4. CONCLUSION

Based on the results obtained, the optimum application of fish oil in feed increasing SGR increasing growth performance, the highest SGR was 2.07% day^{-1}, the best efficiency feed 85.85%, EPA content was 30.7 mg^{-1} 100 and DHA was 10.6 mg^{-1} 100 gr.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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