p-ISSN. 2579-4752
e-ISSN. 2620-7397

Akuakultura, 8:2 (2024): 25-29

AKUAKULTURA

Optimization of Commercial Feed with Moringa Leaf Powder (*Moringa oleifera*) for the Growth of Nilem Fish Fingerlings (*Osteochilus hasselti*)

Optimasi Pakan Komersial dengan Tepung Daun Kelor *(Moringa oleifera)* untuk Pertumbuhan Benih Ikan Nilem *(Osteochilus hasselti)*

Received: April 2024, Revised: June 2024, Accepted: June 2024
DOI: 10.35308/ja.v8i2.9319

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Abstract

This study aims to test the impact of these additions on the growth of nilem fish Fingerlings. The research design was a completely randomized design (CRD) with six treatments and three replicates by adding moringa leaf meal (0%, 2%, 4%, 6%, 8%, and 10%) to commercial feed. The characteristics observed in this study included feed conversion ratio (FCR), specific growth rate, survival rate (SR), absolute length and weight growth, and water quality. Analysis of variance (ANOVA) was used to evaluate the data, and Duncan's test was performed subsequently. The results showed that although there was no significant effect (P>0.05) on tilapia fry or survival rate (SR), the addition of moringa leaf meal to commercial feed had a significant effect (P<0.05) on tilapia larval growth in terms of absolute length and weight growth, specific growth rate, and Feed Conversion Ratio (FCR). The ideal composition for nilem Fingerlings development was 6%; the absolute values for length and weight growth were 1.13 cm and 0.33 g, the specific growth rate was 1.27%/day, the FCR was 1.41, and the survival rate of nilem fry was 93.33%.

Keywords: *Moringa oleifera, Osteochilus hasselti, Feed, Growth*

Abstrak

Penelitian ini bertujuan untuk menguji dampak penambahan tersebut terhadap pertumbuhan benih ikan nilem. Rancangan penelitian yang digunakan adalah desain acak lengkap (RAL) dengan enam perlakuan dan tiga ulangan, dengan menambahkan tepung daun kelor (0%, 2%, 4%, 6%, 8%, dan 10%) ke dalam pakan komersial. Karakteristik yang diamati dalam penelitian ini meliputi rasio konversi pakan (FCR), laju pertumbuhan spesifik, tingkat kelangsungan hidup (SR), pertumbuhan panjang dan berat absolut, serta kualitas air. Analisis varians (ANOVA) digunakan untuk mengevaluasi data, dan dilakukan uji Duncan selanjutnya. Hasil penelitian menunjukkan bahwa meskipun tidak ada pengaruh signifikan (P>0,05) terhadap benih ikan nilem atau tingkat kelangsungan hidup (SR), penambahan tepung daun kelor ke dalam pakan komersial memiliki efek signifikan (P<0,05) terhadap pertumbuhan larva ikan nilem dalam hal pertumbuhan panjang dan berat absolut, laju pertumbuhan spesifik, dan Rasio Konversi Pakan (FCR). Komposisi ideal untuk perkembangan benih nilem adalah 6%; nilai absolut untuk pertumbuhan panjang dan berat adalah 1,13 cm dan 0,33 g, laju pertumbuhan spesifik adalah 1,27%/hari, FCR adalah 1,41, dan tingkat kelangsungan hidup benih ikan nilem adalah 93,33%.

Kata Kunci : Moringa oleifera, Osteochilus hasselti, Pakan, Pertumbuhan

1. Introduction

The nilem (*Osteochilus hasselti*) is a freshwater resource that has great potential for improvement and has the potential to be an excellent aquaculture product. It is also relatively easy to rear and has a high reproductive rate (Putriani & Jati, 2023; Fira *et al*., 2021). Indonesians have been breeding nilem fish for a very long time. Hylem fish farming is profitable regarding economics, environmental sustainability, and aquaculture reproduction. Patchouli is also famous for its meat and eggs, which have a delicious taste (Safitri *et al*., 2022). One of the obstacles to fish farming is its prolonged growth; one of the contributing factors is feed. Therefore, alternatives are needed to increase growth by providing high nutrient feed (Reverter *et al*., 2020).

The protein content required by nilem fish ranges from 27% to 42% (Qomaria, 2023). Studies from the Center for Development and Quality Testing of Fishery Products show that nilem fish is very acceptable for consumption, evident from its

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protein level which reaches 38.83%, calcium content of 0.98%, and water content of 3.14%. Success in aquaculture depends not only on cultivation techniques alone but also on the production and use of quality feed to grow fish larvae or Fingerlings (Nugrahesthi *et al*., 2023; Melanie *et al*., 2023).

In aquaculture activities, feed is an important factor affecting cultured fish's growth and survival. The fish feed consists of natural feed and artificial feed. Natural food such as plankton, water fleas, and artemia, while artificial food comes from ingredients processed ingredients that meet the needs of fish. One type of artificial feed that meets these requirements is pellets (Rahman *et al*., 2017). Feed costs can reach more than 60% of production costs (Prayogo *et al*., 2023). Over time, feed prices have increased while the selling price of fishery products has remained relatively stable. This has a significant impact on aquaculture as the raw materials for feed manufacture are imported from abroad. The higher the protein content in the feed, the higher the feed price; hence, there is a need to supplement with low economic value ingredients to minimize feed costs. Alternative feed ingredients can come from green plants with high nutritional content (Akbar *et al*., 2023; Hasby *et al*., 2020). One of the plants with high nutritional content is Moringa leaves (Peñalver *et al*., 2022; Hidayati *et al*., 2023; Dellima & Sari, 2022).

Moringa is a plant that grows in the tropics and greatly benefits the medical and industrial fields. In addition, Moringa leaves can be an alternative ingredient in fish feed as a source of protein. The addition of moringa leaf meal into fish feed aims to complement the nutrients in commercial feed. Moringa leaves contain 27.1% protein, 2.3% fat, and 19.21% crude fibre (Patil *et al*., 2022). Moringa leaves are also available throughout the year and are a relatively cheap alternative raw material for feed.

2. Materials and Methods

2.1 Time and Place

This research was conducted from May to July 2023 at the Fish Nursery and Hatchery Laboratory, Faculty of Marine Science and Fisheries, Syiah Kuala University, Banda Aceh.

2.2 Experimental design

This study used an experimental method using a completely randomized design (RAL) design with 6 treatments and 3 replicates. The treatment (P) carried out in this study refers to previous research (Husain & Tuiyo, 2023), which uses moringa leaf flour which is applied as follows:

- PA: Commercial feed without moringa flour
- PB: Commercial feed with 2% Moringa leaf meal
- PC: Commercial feed with 4% Moringa leaf meal
- PD: Commercial feed with 6% Moringa leaf meal
- PE: Commercial feed with 8% Moringa leaf meal
- PF: Commercial feed with 10% Moringa leaf meal

2.3 Experiment Procedure

a) Making Moringa Leaf Flour

The moringa leaves used are old moringa leaves because old moringa leaves contain higher protein than young moringa leaves (Hidayati *et al*., 2023). The fresh weight of moringa leaves used was 1.5 kg, picked directly from the tree and then washed using running water to remove dirt attached to the moringa leaves. Clean moringa leaves are air-dried for one day until they moringa leaves become dry. After drying, moringa leaves are ground using a blender to get finer results, then filtered using a coconut milk filter with a diameter of 16 cm. The weight of the ground moringa flour is 500 grams. After the moringa flour is smooth, place it in a jar (Hidayati *et al*., 2023).

b) Feed Manufacturing

The commercial feed used was the FF999 feed type, which was crushed to a powdery texture (Sary *et al*., 2022). Moringa leaf meal was added to the crushed feed according to the composition used: 0%, 2%, 4%, 6%, 8%, and 10% for 1 kg of commercial feed. The adhesive was added after the commercial feed and moringa flour were evenly mixed. The adhesive used was 10 grams of tapioca flour, and then enough water was added. Next, the feed was moulded.

c) Preparation of Research Containers

The study was conducted using 18 25-litre containers, each equipped with an aeration device to maintain the dissolved oxygen concentration in the water. Before use, the containers were first washed using clean water to prevent the emergence of pathogens during the study, and then the washed containers were dried. After all containers were clean, each container was filled with 15 liters of water (Sary *et al*., 2022).

d) Fish Seed Preparation

The test fish used were nilem fish Fingerlings obtained from the Kuala Batee Fish Seed Center (BBI), Southwest Aceh. A total of 180 fish with a fish length of 6 cm. The test fish Fingerlings were acclimatized for 3 days and fed with commercial feed (Sary *et al*., 2022). This was done so that the fish were not stressed and could adapt to the new environment. The test fish Fingerlings were weighed to determine their body weight and length to determine uniformity. After acclimatization, the test fish Fingerlings was ready to be stocked at 10 fish/container density.

e) Care of Test Fish

Feed that is ready to be moulded is immediately given to the Nilem fish. Fish are fed 3 times daily with feeding times at 07.00 WIB, 12.00 WIB, and 17.00 WIB for 40 days. By feeding the fish as much as 5% of its body weight. Sampling was done on day 0 of treatment and then again every ten days (Sary *et al*., 2022).

2.4 Water Quality Measurement

Measurements of temperature, pH, and DO were carried out *in the* morning at 08.00 WIB *in situ*, while measurements of ammonia levels were carried out *ex situ* and then tested in the laboratory.

2.5 Data Analysis

Analysis of variance (ANOVA) was used to test the collected data and determine the impact of the given therapy. Duncan's test was applied to determine the impact between treatments if there was a significant effect. Furthermore, BNT or BNJ tests were conducted using the SPSS program, depending on the coefficient of variance (COV) value. A Duncan test is conducted if the KK value presented is more than 10%. If the KK value presented is more than 5%, the Least Significant Difference Test (BNT) is performed. If the KK value is less than or equal to 5%, the Honest Real Difference Test (BNJ) is performed (Melanie *et al*., 2023).

3. Results and Discussion

3.1 Absolute Growth in Weight and Length

The ANOVA test findings showed that the length development of nilem Fingerlings was significantly affected ($P<0.05$) by the addition of moringa leaf meal in the commercial feed for nilem Fingerlings. Table 2 illustrates the actual changes noticed between treatments based on the findings of Duncan's further tests. With the addition of 6% moringa leaf meal, treatment D had the maximum absolute length of nilem Fingerlings (1.13 cm), while treatment A (control) had the lowest

result (0.70 cm) when no moringa leaf meal was added. It is believed that treatment D, which had high absolute length growth and an added dose of 6% moringa leaf meal in the commercial feed, has an ideal protein content for developing nilem Fingerlings. The tilapia body effectively uses the amount of feed given as a source of development and energy. This is in accordance with the statement of Melanie *et al*. (2023) that energy sources from feed, such as protein, carbohydrates, and fat, have an impact on growth.

Table 1. Research Result Data

Treatment	Absolute length (cm)	Absolute Weight (g)	*Specific Growth Rate* (%/Day)	*Feed Conversion Ratio* (FCR)	*Survival Rate* (SR) (%)
A (Control)	0,70±0,08^{a}	0,17±0,02^{a}	0,63±0,21^{a}	2,63 ± 0,22^{b}	86,66±5,77
B (2%)	0,87±0,10^{b}	0,22±0,03^{ab}	0,95±0,07^{b}	2,22 ± 0,73^{b}	93,33±5,77
C (4%)	0,96±0,11^{b}	0,27±0,01^{b}	1,12±0,80^{bc}	1,86 ± 0,12^{ab}	86,66±5,77
D (6%)	1,13±0,04^{c}	0,33±0,02^{c}	1,27±0,04^{c}	1,41 ± 0,46^{a}	93,33±5,77
E (8%)	0,88±0,06^{b}	0,24±0,01^{b}	1,10±0,12^{bc}	2,21±0,32^{b}	86,66±11,5
F (10%)	0,81±0,09^{a}	0,23±0,04^{b}	0,98±0,12^{b}	2,61±0,36^{b}	83,33±11,5

Note: Values with different superscripts indicate significant differences and values with the same superscript indicate no significant differences.

It is believed that the lack of moringa leaf meal in the commercial feed led to inadequate protein content, which in turn led to poor development in absolute length of the nilem Fingerlings produced in the control treatment. This supports the claim made by Sary *et al*. (2022) that the ratio of protein to energy in fish feed has the most impact on the development or growth of body tissues. The results showed that 6% Moringa leaf meal added to commercial feed is useful in shortening the total time required for nilem Fingerlings. ANOVA test results showed that the addition of moringa leaf meal to commercial feed significantly (P<0.05) affected the absolute weight growth of nilem Fingerlings. Table 2 illustrates the differences between treatments based on Duncan's further test. With the addition of an additional dose of 6% moringa leaf meal in the commercial feed, treatment D had the most significant absolute weight growth of the tilapia Fingerlings, amounting to 0.33 g; the control treatment had the lowest absolute weight growth, amounting to 0.17g.

It is believed that the high absolute weight gain seen in this study is due to the high protein content of Moringa leaves, which is necessary for developing nilem Fingerlings. This supports the statement of Epram *et al*. (2021) that various variables, including the amount of protein in the diet and the amount of feed consumed, influence fish development. The addition of 6% moringa flour with a protein content of 33.04% in commercial feed proved effective in increasing the absolute weight of nilem fish Fingerlings based on the results of the study, while the low absolute weight growth in the control treatment was thought to be due to the absence of moringa flour in commercial feed.

3.2 Specific Growth Rate

Table 1 shows that adding moringa leaf meal in commercial feed to the diet of nilem had a significant impact (P<0.05) based on the ANOVA test findings in this study. Additional testing revealed a striking variation. With the addition of 6% moringa leaf meal, treatment D had the most significant specific growth rate of hippopotamus, at 1.27%/day; the control treatment had the lowest, at 0.63%/day. Due to the amount of moringa leaf meal added to the commercial feed and the increased amount of crude fibre in the feed, which prevented the tilapia from digesting the feed, the specific growth rate dropped in treatment F at a dose of 10%. The statement of Epram *et al*. (2021) that the type and amount of crude fibre in the feed determine the ability of fish to digest it is consistent with this. According to Husain and Tuiyo's study (2023), P3 with an added dose of 6% Moringa leaf meal had the largest specific growth rate, 0.93%/day, while the control treatment had the lowest value, 0.80%/day.

The most excellent specific growth rate was obtained with treatment D. This is because the hippopotamus Fingerlings used moringa leaf meal added to the commercial feed at a dose of 6% ideally to increase feed efficiency, which in turn affected the protein stored in the body for the specific growth rate of the hippopotamus Fingerlings. The lack of moringa leaf meal in the commercial feed is thought to cause the low specific growth rate in the control treatment. This means that the hippopotamus Fingerlings used less of the feed's nutritional content than the feed that had moringa leaf meal added.

Fish weight would increase if the feed obtained is good and the quality and quantity are needed to maintain its weight, as described by Setiyowati *et al*. (2021). This shows how the reaction of fish to feed affects the growth rate of fish as well as the composition and growth rate of feed so that nilem fish can make the best use of it for growth. According to Setiyowati *et al*. (2021), the ratio of protein to energy in fish feed has the most impact on the development or expansion of body tissues.

3.3 Feed Conversion Ratio

The amount of feed given compared to the amount of fish meat produced is called the feed conversion ratio Epram *et al*. (2021). According to Setiyowati *et al*. (2021), for the economic viability of the aquaculture industry, the optimal FCR (Feed Conversion Ratio) value of fish feed is between 1.5 and 2, and it is not recommended to exceed 2. The utilization value of eaten feed increases with a lower FCR (*Feed Conversion Ratio*) value and vice versa. The degree of feed consumption decreases as the FCR value increases. FCR of nilem Fingerlings was significantly affected (P<0.05) by the addition of moringa leaf meal to commercial feed, according to the findings of ANOVA test. With the addition of 6% moringa leaf meal, treatment D had the lowest FCR (1.41), indicating that the tilapia had excellent nutrient absorption and conversion to meat. Meanwhile, treatment A produced the most significant FCR value, which was 2.63. According to research by Epram *et al*. (2021), treatment C, with an additional dose of 4.53 per cent moringa leaf meal, had the largest FCR findings, namely 2.35, while the control treatment C had the lowest value, namely 2.53.

The reason for the high feed conversion ratio is that nilem fish do not fully absorb the feed they consume. This is consistent with the claim made by Setiyowati *et al*. (2021) that high feed conversion ratios are caused by fish not using feed to its full potential, so nutrients are lost because they are excreted in fish feces rather than being fully absorbed by the body. In addition, Setiyowati *et al*. (2021) reported that giving fish feed in the form of moringa leaf flour affects the feed conversion value of fish. Many variables can affect high or low feed conversion values, but the quality and amount of feed, fish species, and fish size are the main ones.

3.4 Sustainability of Life

The study findings showed that the survival rate (SR) of nilem Fingerlings was not significantly affected (P>0.05) by the addition of moringa leaf meal to commercial feed. The tilapia Fingerlings in this study had survival rates ranging from 83% to 93%; treatments A and D had the greatest survival rates, at 93.33%, while treatment F had the lowest rate, at 83.33%. This is

consistent with the study by Husain and Tuiyo, (2023), where the survival rate of nilem fish Fingerlings in that study varied from 90% to 100%.

According to this study, nilem fish Fingerlings have a high survival rate, indicating that they can adapt well to rearing conditions and utilize the nutrients provided efficiently. The findings of this study support the hypothesis that feeding nilem fish Fingerlings with varying moringa leaf composition has no effect on the ability of fish Fingerlings to survive. This is consistent with the statement made by Husain and Tuiyo (2023) that both internal and external factors have an impact on survival rates. Fish age and environmental adaptability are examples of internal elements; abiotic conditions, competition between species, and increased parasites and predators are examples of external factors.

3.5 Water Quality Parameters

The development and survival of fish reared in aquaculture is highly dependent on the water quality in the rearing medium. The water condition of the rearing medium was assessed by measuring water quality indicators such as temperature, pH, and dissolved oxygen (DO). Each treatment was measured throughout the study, namely on days 10, 20, 30, and 40, as well as before the first day of fish rearing. The results of the investigation resulted in temperature readings between 28.6 and 29.8^{o} C; this range is still feasible for the maintenance of nilem fish Fingerlings; this is in accordance with the statement of Melanie *et al*., (2023) that nilem fish prefer temperatures between 25 and 32^{o} C.

Table 2. Water Quality Measurement Results

Treatment	Measurement Results		
	Temperature (^{0} C)	pH	DO (mg/l)
A (Control)	28,7-29,6	7,5-7,9	5,6-5,9
B (2%)	28,8-29,6	7,3-7,8	5,6-5,8
C (4%)	28,6-29,8	7,4-7,9	5,6-5,9
D (6%)	28,7-29,8	7,6-7,9	5,6-5,8
E (8%)	28,7-29,5	7,3-7,9	5,5-5,8
F (10%)	28,6-29,8	7,3-7,9	5,6-5,9

The acidity (pH) readings taken throughout the study varied from 7.3 to 7.9. This is consistent with the statement of Melanie *et al*., (2023) that nilem fish should have a pH between 7-8. This suggests that the pH range used in the study is still suitable for the growth of hippopotamus Fingerlings. Throughout the investigation, dissolved oxygen (DO) levels varied from 5.5 to 5.9 mg/L. Melanie *et al*., (2023) stated that 5-6 mg/L is the ideal DO for the study of hippopotamus. The water quality indicated that the hippopotamus was placed in a suitable environment for its rearing.

3.6 Proximate Analysis

Protein assay was the proximate analysis used in this investigation. Table 3 displays the test findings for five samples (moringa leaf meal and 2%, 4%, 6%, 8%, and 10% additions to the commercial feed). It is believed that the addition of moringa meal to commercial feed can help increase the protein content of the feed based on these findings.

Table 3. Proximate Test Results

Sample Code	Protein Composition (%)
B (2%)	27,17
C (4%)	29.57
D (6%)	33,04
E (8%)	35,57
F (10%)	37,66

Different types of protein were present in the proximate test findings for each treatment when moringa flour was added to the commercial feed. Treatment F (addition of 10% moringa leaf meal) had the highest protein level, at 37.66%. The increasing amount of moringa leaf meal added to the commercial feed is assumed to be the cause of the high protein content in treatment F.

4. Conclusion

Based on the research conducted, it can be concluded that the addition of moringa flour in commercial feed influences absolute growth in length and weight, specific growth rate, and FCR (Feed Conversion Ratio), but has no effect on survival (SR) of nilem fish Fingerlings. In this study, treatment D with an additional dose of moringa flour (6%) showed absolute growth values of length and weight of 1.13 cm and 0.33 g, respectively, specific growth rate of 1.27%/day and FCR of 1.41, and survival of 93.33%.

Acknowledgments

This study is part of the university's internal research, supported by the Institute for Research and Community Service (LPPM) and the Faculty of Marine and Fisheries, Syiah Kuala University.

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