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Combination of Moringa Leaf Meal (*Moringa oleifera*) and Black Soldier Fly Larvae Meal (*Hermetia illucens*) in Feed to Support Growth Performance in Stiped catfish (*Pangasius* sp.) Aquaculture

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Abstract

This study aimed to evaluate the effects of incorporating Moringa leaf flour and maggot flour into feed on the growth performance of stiped catfish (*Pangasius* sp.). The experiment was conducted using a Completely Randomized Design (CRD) with six treatments and three replications: A (control), B (25% Moringa leaf flour + 5% maggot flour), C (20% Moringa leaf flour + 10% maggot flour), D (15% Moringa leaf flour + 15% maggot flour), E (10% Moringa leaf flour + 20% maggot flour), and F (5% Moringa leaf flour + 25% maggot flour). ANOVA results showed a significant effect ($P<0.05$) on absolute length and weight gain, feed conversion ratio (FCR), feed efficiency (FE), and specific growth rate (SGR), but no significant effect on survival rate (SR) ($P>0.05$). Treatment D produced the best growth performance, with an absolute length of 2.06±0.34 cm, absolute weight of 3.91±0.50 g, survival rate of 100.0±0.00%, feed efficiency of 62.34±7.65%, feed conversion ratio of 1.62±0.19, and specific growth rate of 1.69±0.22% per day. Based on the 45-day study, combining 15% Moringa leaf flour and 15% maggot flour in treatment D yielded the best results for stiped catfish growth parameters.

Keywords: feed efficiency, fish growth, maggot flour, moringa leaf flour, *Pangasius* sp.

I. INTRODUCTION

Striped catfish (*Pangasius* sp.) is one of the essential aquaculture commodities in Indonesia with significant economic value (Anjar *et al.,* 2022). This species is known for its superior nutritional profile, including high levels of omega-3 fatty acids and low cholesterol content, making it a potential functional food source for various age groups (Anjar *et al.,* 2022). However, its consumption remains relatively low compared to other freshwater fish, primarily due to limited public awareness of its nutritional benefits. On the production side, stiped catfish farmers face several technical and economic challenges, including suboptimal farming management practices and high production costs, especially in feed components (Putri *et al.,* 2020; Muchlisin *et al.,* 2016). According to Yanuar (2017), one widely adopted strategy to address these challenges is formulating homemade feed to reduce production expenses.

Specifically, feed costs can account for 60–70% of the total production expenses, making it a critical factor in determining the efficiency of aquaculture operations (Putra *et al.,* 2019, 2021, 2022, 2025). A recommended solution is the development of alternative feeds based on locally available ingredients by implementing independent feed technology (Putra *et al.,* 2022). Although fish meal and soybean meal are conventional protein sources in feed formulations, their high costs remain a major constraint (Varianti *et al.,* 2017). Meanwhile, feed quality standards for stiped catfish fry require a minimum percent protein content of 30% (BSNI, 2009). Therefore, it is necessary to explore more economical alternative protein sources such as Moringa leaf flour (*Moringa oleifera*) and black soldier fly larvae flour (*Hermetia illucens*), which have the potential to substitute conventional ingredients without compromising the nutritional quality of the feed.

Moringa leaves (*Moringa oleifera*) are a promising plant-based feed ingredient and an alternative protein source in fish feed formulations due to their relatively complete nutrient profile (Astiyani *et al.,* 2020). Based on proximate analysis, Moringa leaf flour contains 27.1% protein, 19.21% crude fiber, and 2.3% fat (Aida *et al.,* 2020). According to Anti *et al.* (2018), the year-round availability and relatively low cost of Moringa leaves make them an ideal raw material for alternative feed. A study by Basir and Nursyahran (2018) demonstrated that including 20% Moringa leaf flour in tilapia feed yielded optimal results, as indicated by increased body weight and survival rate. Similarly, Naria *et al.* (2022) reported that incorporating 30% Moringa leaves into common carp feed resulted in a higher growth rate than other treatments.

Maggots (*Hermetia illucens*) are a potential alternative protein source for fish feed formulations. Their high protein content (approximately 40%) and ease of cultivation make them a promising feed ingredient (Santi *et al.,* 2020). In addition, maggots possess several advantages, including a chewy texture that can enhance feed digestibility in fish (Supriyatna *et al.,* 2015). The effectiveness of maggots as a feed ingredient has been demonstrated in various fish species. For instance, subtituting maggot meal up to 40% in the feed of balshark (Hemibagrus nemurus) resulted in a specific growth rate of 6.51% (Fahmi *et al.,* 2009). Similarly, in common carp (*Cyprinus carpio*), feeding with 75% maggot-based feed led to a daily growth rate of 1.77% and an average final weight of 5.92 g (Prama *et al.,* 2022).

Although studies on the use of maggots and Moringa leaf flour (*Moringa oleifera*) have been conducted on several fish species, research on combining these two ingredients in stiped catfish (*Pangasius* sp.) feed has not been previously reported. As an omnivorous species, catfish can efficiently digest and utilize both animal-based protein sources (such as maggots) and plant-based protein sources (such as Moringa leaves). Therefore, further investigation into substituting fish meal with maggot and Moringa leaf flour in stiped catfish feed is essential to evaluate their potential to enhance growth performance and reduce production costs.

II. MATERIALS AND METHODS

2.1 Experimental Animals

This study was conducted over three-months (June–August 2024) at PPI Lambada Lhok, Baitussalam Subdistrict, Aceh Besar. A Completely Randomized Design (CRD) comprised six treatment groups with three replications each. The treatments involved various combinations of Moringa leaf flour (*Moringa oleifera*) and maggot flour (*Hermetia illucens*), adapted from proposed by Rachmawati and Istiyanto (2013). Moringa leaves were collected from local gardens, then thoroughly cleaned, sun-dried, and floured. Maggot flour was produced from a certified supplier. Experimental feed formulated by blending the main ingredients (fish meal, tapioca, rice bran, and vitamins) according to designated treatment proportions, followed by pelleting and drying. The test animals consisted of stiped catfish (*Pangasius* sp.) fingerlings, with an initial average weight of 3.5±0.33 g, reared in controlled containers.The fish were fed the experimental diets to satiation three times daily. Growth performance and survival rate parameters were observed throughout the study. Data were analyzed using Analysis of Variance (ANOVA), followed by Duncan's Multiple Range Test at a 5% significance level. The tested treatment combinations included: control (0% Moringa:0% maggot), B (25%:5%), C (20%:10%), D (15%:15%), E (10%:20%), and F (5%:25%) of Moringa leaf flour and maggot flour, respectively.

2.2 Research Procedure

This study utilized 18 circular containers, each with a diameter of 30 cm and a capacity of 25 L . Prior to use, the containers were sterilized through washing, rinsing, and drying, then filled with 20 L of water. Each container was equipped with an aeration system to ensure adequate dissolved oxygen levels and labeled according to the assigned treatment group.

Stiped catfish (*Pangasius* sp.) fingerlings with an initial mean weight of 3.5±0.33 g were stocked at a density of 10 fish per container and reared for 45 days. Prior to the rearing period, the fish were acclimatized for one hour to the environmental conditions and fasted for 24 hours to clear their digestive tracts. The formulated diets were administered at 5% of total biomass, with a feeding conducted three times daily 08:00, 13:00, and 18:00 GMT+7 Jakarta Time . Water quality was maintained through regular siphoning and periodic monitoring of water parameters. Growth performance was assessed weekly by measuring body weight using a digital scale (precision: 0.01 g) and total length using a ruler (precision: 0.1 cm). Baseline measurements were taken prior to stocking the fingerlings into the rearing containers.

2.3 Research Parameters

Absolute Length Growth (Putra *et al.,* 2019):

L = Final length (Lt) – Initial weight (L0)

Absolute Weight Growth (El Rahimi *et al.,* 2021):

W= Final weight (Wt) – Initial weight (W0)

Survival Rate (Muhammadar *et al.,* 2023):

$$SR = \frac{Number\ of\ fish\ at\ the\ end\ of\ the\ experiment\ (Nt)}{Number\ of\ fish\ at\ the\ beginning\ of\ the\ experiment\ (No)} \times 100$$

Feed Conversion Ratio (Putra *et al.,* 2019):

$$FCR = \frac{Total\ feed\ consumed\ (F)}{Wt - W0}\ x\ 100$$

Feed Efficiency (Putra *et al.,* 2025) :

$$FE = \frac{Final\ weight\ (Wt) - Initial\ weight\ (W0)}{Total\ feed\ consumed\ (F)} x100$$

Specific Growth Rate (Putra *et al.,* 2018):

$$SGR = \frac{Logaritma\ natural\ (Ln)(Wt - W0) ln ln\ Wt - ln ln\ W0}{Duration\ of\ rearing\ period\ (t)} \times 100$$

2.4 Water Quality

Throughout the 45-day rearing period, water quality parameters namely temperature, pH, and dissolved oxygen (DO) were monitored daily at midday in all experimental units using a calibrated water quality meter. To ensure optimal environmental conditions for fish growth, water replacement was performed weekly by removing 30% of the total water volume from each container, following the method described byAziz & Oktaviana (2022).. The replacement water used was clean, aerated and pre-adjusted to match the water temperature. This procedure was implemented to sustain environmental stability and reduce the buildup of toxic compounds such as ammonia and nitrite throughout the rearing period.

2.5 Data Analysis

Data analysis was conducted using Analysis of Variance (ANOVA) based on a Completely Randomized Design (CRD). When significant differences among treatments were identified, Duncan's Multiple Range Test at a 95% confidence level ($\alpha = 0.05$) to determine specific differences between treatments. The analysis was carried out comprehensively, with consideration given to all essential statistical assumptions, including assessments of normality and homogeneity of variance, to ensure the accuracy and reliability of the results. The results were quantitatively interpreted to assess the impact of various feed combinations on the growth performance parameters of striped catfish.

III. RESULT

The results of the study revealed that the substitution of moringa leaf meal and maggot meal in the diet significantly influenced the growth performance of Pangasius fingerlings (Table 1). Treatments D (15% moringa leaf meal + 15% maggot meal) and F (5% moringa leaf meal + 25% maggot meal) produced the highest absolute weight gains of 7.35±0.35 g and 7.24±1.08 g, respectively. These values were significantly greater than those of the control group (5.38±0.22 g) and other treatments ($P<0.05$). A comparable pattern was observed in the absolute length parameter, with treatments D and F attaining average lengths of 2.06±0.34 cm and 2.04±0.26 cm, respectively. These results suggest that the optimal combination of Moringa leaf meal and maggot meal can effectively enhance linear growth in Pangasius fingerlings.

Feed efficiency parameters also demonstrated a significant improvement in Treatment D, with a feed efficiency (FE) of 62.34±7.65% and a feed conversion ratio (FCR) of 1.62±0.19values superior to those observed in the control group (FE 49.77±4.66%, FCR 2.02±0.18). These findings suggest that a balanced

Table 1. Results of measured parameters in Black Tiger Shrimp (*Penaeus monodon*) rearing for 60 days

Parameters	Treatment					
	PA	PB	PC	PD	PE	PF
W0 (g)	3,44±0,25[a]	3,71±0,51[a]	3,77±0,28[a]	3,43±0,25[a]	3,36±0,28[a]	3,65±0,41[a]
Wt (g)	5,38±0,22[a]	5,73±0,11[a]	5,93±0,23[a]	7,35±0,35[b]	6,36±0,86[ab]	7,24±1,08[b]
Long Absolute (cm)	1,15±0,63[a]	1,24±0,50[a]	1,51±0,16[ab]	2,06±0,34[b]	1,78±0,22[ab]	2,04±0,26[b]
Weight Absolute (g)	1,94±0,32[a]	2,03±0,40[a]	2,16±0,43[ab]	3,91±0,50[c]	3,00±0,63[bc]	3,59±0,67[c]
SR (%)	96,66±5,77[a]	96,66±5,77[a]	100,0±0,00[a]	100,0±0,00[a]	100,0±0,00[a]	100,0±0,00[a]
FCR	2,02±0,18[b]	1,85±0,13[ab]	1,88±0,03[ab]	1,62±0,19[a]	1,73±0,12[a]	1,74±0,04[a]
FE (%)	49,77±4,66[a]	54,22±3,74[ab]	53,27±1,00[a]	62,34±7,65[b]	57,79±4,02[ab]	57,44±1,49[ab]
SGR (%) / Day	1,00±0,18[a]	0,98±0,26[a]	1,00±0,22[a]	1,69±0,22[b]	1,41±0,17[b]	1,51±0,09[b]

Note: Different superscript letters indicate significant differences between treatments, and the ± sign represents the standard deviation. The mean values in the same column with the addition of fermented moringa leaf flour and maggot flour in the feed for catfish fingerlings show significantly different doses ($P<0.05$). A=0%, B=25%+5%, C=20%+10%, D=15%+15%, E=10%+20%, F=5%+25%.

dietary inclusion of Moringa leaf meal and maggot meal 15%:15% ratio not only promotes growth performance but also enhances feed utilization efficiency. Additionally, all treatment groups achieved high survival rates, ranging from 96.66–100%, indicating that the inclusin of these alternative feed ingredients is safe for Pangasius fingerlings.

IV. DISCUSION

Fish growth, which encompassess increases in weight, length, and body volume over time, is strongly influenced by feed quality (Effendie, 2002). The results of this study indicate that the combination of Moringa leaf meal and maggot meal in the diet significantly enhanced the growth of *Pangasius* spp. Notably, treatment D (15% Moringa leaf meal + 15% maggot meal) produced the greatest absolute length gain (2.06±0.34 cm), surpassing both the control and other treatment groups. These findings align with previous studies on various fish species. Aliyas *et al.,* (2024) reported that a 3% inclusion of Moringa leaf meal in diet of *Cyprinus carpio* resulted in a length gain of 1.21 cm, while Mulyani and Haris (2021) observed a length gain of up to 4.67 cm in Pangasius fingerlings with a 50% dietary inclusion of maggot meal. Collectively, these results support the notion that a well-balanced combination of these alternative feed ingredients can effectively supply the essential nutrients required for optimal fish growth (Oluduro, 2012).

This study supports previous research on the use of alternative feed ingredients for freshwater fish. Sari *et al.,* (2024) reported that the inclusion of Gliricidia leaf meal in fish diets significantly improved the growth of pomfret (*Colossoma macropomum*). Similarly, our findings align with those of Ranggana *et al.,* (2023), who documented limited growth in *Cyprinus carpio* (0.79 cm) when fed exclusively with commercial feed, underscoring the inadequacy of standard diets in fulfilling comprehensive nutritional needs of fish.

The observation that the control treatment (A) exhibited the lowest growth (1.15±0.63 cm) highlights the critical role of incorporating alternative protein sources in aquafeed formulations. The limited nutritional profile of the control diet contributed to reduced growth, a pattern similarly reported in previous studies. Based on the present findings, a feed formulation incorporating 15% *Moringa oleifera* leaf meal and 15% *Hermetia illucens* larval meal is recommended for *Pangasius* sp. culture, as it demonstrated the most favorable growth performance. This dietary combination not only enhanced linear growth but also improved feed utilization, as evidenced by superior feed conversion ratio (FCR) and feed efficiency (FE) to the control. These results underscore the potential of such formulations to support more cost-effective and sustainable aquaculture practices.

Based on 45 days of observation during the rearing period, treatment D (a combination of 15% *Moringa oleifera* leaf meal and 15% *Hermetia illucens* larvae meal) exhibited a significantly higher weight gain (P<0.05) compared to the other treatment group. This result aligns with the finding of Prajayati *et al.,* (2020), who reported a 4.34% increase in tilapia weight gain following the incorporation of 50% maggot meal in the diet. Mardiana *et al.,* (2023) further emphasized the importance of maggot meal with high lipid content in supplying metabolic energy, thereby allowing dietary protein to be more effectively utilized for somatic growth. These results indicate the critical role of feed quality particularly the balance between protein and lipid content in optimizing the growth performance of cultured fish.

The survival rate (SR) parameter showed no statistically significant differences among treatments (P>0.05). Treatments C through F achieved a perfect SR (100%), while treatments A and B recorded 96.6%. The consistently high SR across all treatment groups demonstrate the strong adaptability of Pangasius fingerlings to a variety of feed formulations. This aligns with findings by Rachmawati (2013), who reported high survival rates in Pangasius fed diets containing maggot meal, and with Astiyanti *et al.,* (2020), who observed a 99.5% survival rate in tilapia supplemented with *Moringa oleifera* leaf meal.

According to Arsad *et al.,* (2017), fish growth performance is influenced by a synergistic interaction between biotic and abiotic factors. The findings of this study underscore the importance of adopting a holistic approach to aquaculture management, in which high-quality nutritional inputs must be complemented by optimal environmental conditions. While feed formulation plays a pivotal role in promoting growth, the stability of environmental parameters remains a crucial factor in achieving optimal culture outcomes. These results further validate that incorporating *Moringa oleifera* leaf meal and maggot meal into feed formulations not only enhances growth but also contributes to overall fish health, as evidenced by the consistently high survival rates across all treatments.

Based on the research findings, Treatment D comprising 15% *Moringa oleifera* leaf meal and 15% maggot meal exhibited the highest feed efficiency performance. The feed conversion ratio (FCR) value of 1.62 ± 0.19 indicates a highly effect conversion of feed into fish biomass. This result aligns with the benchmark for efficient feed utilization established by Nurulaisyah *et al.,* (2021), which considers FCR values below 3 as efficient. Additionally, the feed efficiency (FE) value of 62.34±7.65% observed in Treatment D reflects the strong capacity of fish to assimilate nutrients. This is consistent with the explanation provided by Iskandar and Elfaridah (2015), who noted that higher FE values are indicative of nutrient absorption and utilization.

The highest specific growth rate (SGR) recorded in Treatment D (1.69±0.22%/day) indicates that this feed formulation offers an optimal nutritional profile to support the metabolism and growth of *Pangasius* sp. This result aligns with the findings of Prama *et al.,* (2022), who observed notable improvement in fish growth when maggot meal was included in the diet. The combination of plant-based protein from *Moringa oleifera* leaf meal and animal-based protein from maggot meal at a 15:15% ratio has been shown to provide a well-rounded amino acid profile. Additionally, the lipid content in maggot meal serves as an efficient source of metabolic energy, further enhancing growth performance (Mardiana *et al.,* 2023).

These findings hold significant implications for advancing sustainable *Pangasius* sp. aquaculture. Feed formulations that incorporate *Moringa oleifera* leaf meal and maggot meal have demonstrated improved growth performance and feed efficiency, while offering a cost-effective and environmentally sustainable alternative to conventional fishmeal. This study reinforces the importance of diversifying protein sources in aquafeeds and highlights the potential of utilizing locally available resources to reduce production costs and enhance the economic viability of *Pangasius* sp. farming.

Throughout the 45-day rearing period, water quality parameters remained within the optimal range for *Pangasius* sp. fingerling cultivation. Recorded water temperature ranged from 29.1 to 30.1°C, aligning with the ideal range of 25–33°C for Pangasius culture reported by Idawati *et al.,* (2018) and consistent with recommendation of Wangni *et al.,* (2019), who suggested 27- 30°C for fingerling maintenance. The pH values remained stable, ranging from 6.81 to 7.42, well within the optimal threshold of 6.5–8.5, which reflects the natural habitat of the species (Bokings *et al.,* 2017) and supports Wangni *et al.,* (2019). Dissolved oxygen

(DO) levels were maintained between 5.7 and 7.2 mg/L, satisfying the minimum requirement of 5.6–7.23 mg/L for optimal growth of Pangasius (Hasan *et al.,* 2022).

The consistent stability of water quality parameters throughout the study reflects an environment well-suited to support the physiological functions of Pangasius fish. The recorded temperature range falls within the optimal thermal window for metabolic activity and growth, while stable pH levels ensure proper acid-base homeostasis within the fish. Additionally, dissolved oxygen concentrations from 5.7–7.2 mg/L were sufficient to sustain efficient respiratory and energy metabolism. These conditions align with established standards in previous research and meet the water quality criteria for Pangasius aquaculture, indicating that environmental factors did not constrain the outcomes of this study.

The consistently optimal water quality conditions maintained throughout the study confirm that the observed variations in growth across feed treatments were attributable to the feed formulation rather than environmental influences. This reinforces the validity of the findings concerning the impact of combining Moringa leaf meal and maggot meal on the growth performance of Pangasius fish. Moreover, these results highlight the critical importance of routine monitoring of water quality parameters in aquaculture operations to sustain an environment conducive to optimal fish development.

V. CONCLUSION

This study demonstrates that the combined use of Moringa leaf meal and maggot meal has a significant positive impact on the growth performance of Pangasius . Among all treatments, Treatment D, comprising15% Moringa leaf meal and 15% maggot meal produced the most favorable outcomes, producing optimal results in absolute length growth, absolute weight gain, feed efficiency (FE), feed conversion ratio (FCR), and specific growth rate (SGR). Additionally , this treatment maintained the highest survival rates. These findings highlight the promising potential of this ingredient combination as an alternative feed formulation to support more cost-effective and sustainable Pangasius aquaculture.. Future studies are recommended to further optimize the proportions ofMoringa leaf meal and maggot meal across a broader substitution range (10–20%) to determine the most efficient dietary formulation.

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REFERENCES

Aida, N., I. Suharman, Adelina. 2020. Pemanfaatan tepung daun kelor (*Moringa oleifera*) yang difermentasi menggunakan Rhyzopus sp. dalam pakan buatan untuk pertumbuhan benih ikan bawal air tawar (*Colossoma macropomum*). *Jurnal Akuakultur SEBATIN,* 1 (1): 51-62.

Aliyas., I. W. Putri, F. A. Dewi. 2024. Perbaikan kualitas pakan ikan mas (*Cyprinus carpio*) dengan penambahan tepung daun kelor (*Moringa oleifera*) dalam meningkatkan pertumbuhan. J*urnal Agrokompleks Tolis,* 4 (1): 83-89.

Anjar, R., A. Yustiati, Y. Andriani. 2022. Teknik pembenihan ikan patin (*Pangasius hypopthalmu*s) sistem corong fishing engineering catfish (*Pangasius hypopthalmu*s). Jurnal Akuatek, 3 (1): 33–40.

Anti, U.T., L. Santoso, D.S.C. Utomo. 2018. Pengaruh suplementasi tepung daun kelor (*Moringa oleifera*) pada pakan terhadap performa pertumbuhan ikan gurami (*Osphronemus gouramy*). *Jurnal Sains Teknologi Akuakultur,* 2 (2): 22-31

Arsad, S., A. Afandy, A. P. Purwadhi, D. K. Saputra, N. R. Buwono. 2017. Studi kegiatan budidaya pembesaran udang vaname (*Litopenaeus vannamei*) dengan penerapan sistem pemeliharaan berbeda. *Jurnal Ilmiah Perikanan dan Kelautan*, 9 (1): 1-14.

Astiyani, W.P., M. Akbarurrasyid, E.A. Prama, I.G. Revaldy. 2020. Pengaruh pemberian tepung daun kelor (*Moringa oleifera*) pada pakan komersial terhadap pertumbuhan ikan nila (*Oreochromis niloticus*). *Marine and Fisheries Science Technology Journal,* 1 (2): 91-96.

Azhari, D, N. I. Mose, R. Jane. 2018. Efisiensi pakan ikan nila (*Oreochromis niloticus*) yang dibudidayakan di sistem akuaponik. *Jurnal Ilmiah Tindalung,* 4 (1): 27–29.

Aziz, R. dan A. Oktaviana. 2022. Application of carbon and nitrogen ratio in the Sangkuriang catfish culture *Clarias gariepinus* var in tarpaulin tanks. *In IOP conference series: Earth and Environmental Science,* 1012 (1): 012017.

Badan Standardisasi Nasional Indonesia (BSNI). 2009. Ikan patin djambal (*Pangasius djambal*). bagian 3 : kelas benih sebar. SNI : 7471.3. Jakarta. www.perikananbudidaya.dkp.go.id. 23 Oktober 2010. 12 hal.

Baleta, F. N. *et al.* 2013. Efficacy of *Sargassum oligocystum* Extract on the Innate Immunity of White Shrimp *Litopenaeus vannamei* and Its Resistance Against *Vibrio algin. Journal of the Fisheries Society of Taiwan,* 40, 241–256

Basir, B. Nursyahran. 2018. Efektivitas penggunaan daun kelor sebagai bahan baku pakan ikan nila (*Oreochromis niloticus*). *Jurnal Ilmu Perikanan,* 7 (2): 7-11.

Bokings, U. L., Y. Koniyo, Juliana. 2017. Pertumbuhan dan kelangsungan hidup benih ikan patin siam (*Pangasius hypophthalmus*) yang diberi pakan buatan, cacing sutra (*Tubifex s*p.) dan kombinasi keduanya. *Jurnal Ilmiah Perikanan dan Kelautan,* 5 (1): 106–111.

Dachi, A. L., Muhammadar, A. A., Sahidhir, I., Putra, D. F. Irwan, Z. A. 2019. Effects of probiotics (rabal) with different doses on the survival, feed conversion, and growth of giant prawns (*Macrobrachium rosenbergii). in IOP Conference Series: Earth and Environmental Science,* vol. 348.

Evendi, E., Karina, S. Putra, D. F. 2017. Pengaruh ekstrak daun kirinyuh (*Euphatorium odoratum* l.) Terhadap daya tetas telur Ikan Bandeng (*Chanos chanos*). J*urnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah*, 2, 33–40.

Fahmi, M.R., S. Hem, I. W. Subamia. 2009. Potensi maggot untuk peningkatan pertumbuhan dan status kesehatan ikan. *Jurnal Riset Akuakultur,* 4 (2): 221-232.

Hasan, B., D. Iriani, T. Warningsih, C. Marlowe, A. Caipang, Z. A. Muchlisin, I. Suharman. 2022. Growth and carcass quality of on-growing river catfish *Hemibagrus nemurus* fed with dietary salted by-catch and fish viscera meal mixtures as fishmeal substitute. *Aquaculture Reports, 2*7 (September), 101343.

Idawati, C. N. Defira, S. Mellisa. 2018. The effect of different life feed on growth and survival of eatfish fry (*Pangasius* sp.). *Jurnal Ilmiah Mahasiswa Kelautan Dan Perikanan Unsyiah,* 3 (1): 14–22.

Iskandar, Elfaridah. 2015. Pertumbuhan dan efisiensi pakan ikan nila (*Oreochromis niloticus*) yang diberi pakan buatan berbasis kiambang. *Jurnal Ziraah*, 40 (1): 18–24.

Mardiana, B. G., D. P. Lestari, Z. Abidin. 2023. Pengaruh tepung maggot (*Hermetia illucens*) pada formulasi pakan terhadap pertumbuhan ikan mas (*Cyprinus carpio*). *Journal of Indonesian Tropical Fisheries,* 6 (2): 150-161.

Muchlisin, Z. A., F. Afrido, T. Murda, N. Fadli, A. A. Muhammadar, Z. Jalil, C. Yulvizar. 2016. The effectiveness of experimental diet with varying levels of papain on the growth performance, survival rate and feed utilization of keureling fish (*Tor tambra*). *Biosaintifika: Journal of Biology & Biology Education,* 8 (2): 172-177.

Muhammadar, A. A., Chaliluddin, M. A., Putra, D. F. Asmawati, M. S. 2018. Study of probiotics of yeast and lactic acid bacteria in feeding on culture of larvae shrimp (*Penaeus monodon*). *IOP Conference Series: Earth and Environmental Science,* 216

Mukti, R. C., Yonarta, D., Pangawikan, A. D. 2019. Pemanfaatan daun Indigofera zollingeriana sebagai bahan pakan ikan patin (*Pangasius* sp.). *Depik* 8

Mulyani, R. dan R. B. K. Haris. 2021. Penambahan tepung maggot pada pelet tepung komersil terhadap pertumbuhan benih ikan patin *Pangasius hypophthalmus*. *Jurnal Ilmu-Ilmu Perikanan dan Budidaya Perairan,* 16 (2): 72-81.

Naria, D. K., S. Y. Lumbessy, D. P. Lestari. 2022. Pemanfaatan tepung daun kelor muda (*Moringa oleifera*) sebagai bahan baku pakan buatan pada budidaya ikan mas (*Cyprinus carpio*). *Journal of Fish Nutrition,* 2 (1): 37-48.

Nurulaisyah, A., N. D. Setyowati, H. B. Astriani. 2021. Potensi pemanfaatan daun singkong (*Manihot utilissima)* terfermentasi sebagai bahan baku pakan untuk meningkatkan pertumbuhan ikan mas (*Cyprinus carpio*). *Jurnal Perikanan,* 11 (1): 13-25.

Oluduro, A. O. 2012. Evaluation of antimicrobial properties and nutritional potentials of *Moringa oleifera* Lam. leaf in South-Western Nigeria. *Malaysian Journal of Microbiology*, 8(2): 59-67.

Prajayati, V. T. F., O. D. S. Hasan, M. Mulyono. 2020. Kinerja tepung maggot dalam meningkatkan efisiensi pemanfaatan pakan formula dan pertumbuhan nila ras nirwana (Oreochromis sp.). *Jurnal Perikanan Universitas Gadjah Mada, 2*2 (1): 27-36.

Prama, E. A., I. Kristiana, W. P Astiyani, V. T. Prajayanti, I. A. Hisina. 2022. Pengaruh pemberian tepung maggot (*Hermetia illucens*) pada pakan komersial terhadap pertumbuhan ikan koki (*Carrasius auratus*). *Marine and Fisheries Science Technology Journal,* 3 (1): 36-42

Effendie, M. I. 2002. Biologi Perikanan. In Yayasan Pustaka Nusantara (Issue, p. Yogyakarta).

El Rahimi, S. A., Razeky, M. M., Perdana, A. W., & Putra, D. F. 2021. The growth performance of common carp (*Cyprinus carpio*) co-cultured with different vegetable plants in aquaponics system. *Depik*, 10(1), 30–34.

Gunawan, G., Huzy, O. M., Jalil, Z., & Putra, D. F. 2024. The effect of frangipani leaf extract *(Plumeria* sp.) on the hatchabiiity and growth of sangkuriang catfish (*Clarias gariepinus)* larvae. *BIO Web of Conferences,* 87.

Muhammadar, A. A., Malasari, N., Afriani, S., Asmawati, M. S., & Putra, D. F. 2023. Effect of addition of rubber seeds flour (*Hevea brasiliensis)* in fish feed on growth and feeding efficiency of Gourami (*Osphronemus goramy*). *IOP Conference Series: Earth and Environmental Science,* 1221(1).

Putra, D. F., Nur, F., Rahimi, S. A. E., & Othman, N. 2019. Effects of different live feed on growth and survival rate of clown loach, *Cromobotia macracantus. IOP Conference Series: Earth and Environmental Science*, 348(1).

Putra, D. F., Trisyahdar, T. N., Dewiyanti, I., & Muhammadar, A. A. 2018. Effect of enhanced Artemia with gamat emulsion on growth performance and survival rate of white shrimp *Litopenaeus vannamei* larvae. *IOP Conference Series: Earth and Environmental Science,* 216(1), 2–7.

Putra, D.F., Rahmawati, M., Abidin, M. Z., & Ramlan, R. 2019. Dietary administration of sea grape powder (*Caulerpa lentillifera*) effects on growth and survival rate of black tiger shrimp (*Penaeus monodon*). I*OP Conference Series: Earth and Environmental Science,* 348(1).

Putra, Dedi Fazriansyah, Abbas, M. A., Solin, N., & Othman, N. 2022. Effects of Dietary *Caulerpa lentillifera* Supplementation On Growth Performance and Survival Rate of Milk Fish, *Chanos chanos* (Forsskål, 1775). *Elkawnie*, 7(2), 395.

Putra, Dedi Fazriansyah, Astari, B., & Arisa, I. I. 2025. *Indigofera* sp. leaf flour stimulate milkfish growth performance (*Chanos chanos*). *BIO Web of Conferences,* 156.

Putra, Dedi Fazriansyah, Azhar, D., Perdana, A. W., Arisa, I. I., & Melanie, K. 2022. The Effect of Different Salinity Concentrations on the Embryogenesis Development of the Freshwater African Catfish, *Clarias gariepinus*, Burchell 1822. *Egyptian Journal of Aquatic Biology and Fisheries,* 26(6), 1329–1347.

Putra, Dedi Fazriansyah, Muhsinah, M., & Arisa, I. I. 2021. The Substitution of soybean meal by fermented tofu dregs in the milkfish (*Chanos chanos*) diet The Substitution of soybean meal by fermented tofu dregs in the milkfish (*Chanos chanos*) diet. I*OP Conf. Series: Earth and Environmental Science,* 674 (012102), 1–6.

Putra, D.F. 2021. Dasar-dasar budidaya perairan. Syiah Kuala University Press. Banda Aceh.

Putri, B. R. T., N. L. G. Sumardani, I. D. P. Singarsa, N. N. Yastini. 2020. Strategi budidaya ikan patin (*Pangasius* sp.) untuk meningkatkan pendapatan kelompok tani ikan mina kencana desa pering kecamatan blahbatuh. *Buletin Udayana Mengabdi, 19 (1): 33–38.*

Rachmawati, D. dan Istiyanto, S. 2013. Efektivitas substitusi tepung ikan dengan tepung maggot dalam pakan buatan terhadap pertumbuhan dan kelulushidupan ikan patin (*Pangasius pangasius*). *Jurnal Saintek Perikanan,* 9 (1): 62-67.

Ranggana H., S. Y. Lumbessy, D. P Lestari. 2023. Pengaruh penggunaan pakan magot (*Hermetia illucens*) terhadap pertumbuhan dan kelangsungan hidup ikan mas (*Cyprinus carpio*). *Journal of Indonesia Tropical Fisheries,* 6 (1): 1-11.

Salsabilla, A., Putra, D. F., Octavina, C., & Maulana, R. 2021. Prevalence and Intensity of Ectoparasites on Cultivated Catfish (*Clarias* sp.) in Aquaculture Ponds and Bioflocs System in Aceh Besar, Indonesia. *IOP Conference Series: Earth and Environmental Science,* 869 (1).

Santi, S., A. T. B. Astuti, J. Pasamboang. 2020. Nilai nutrisi 42 marine and fisheries magot black solder fly (*Hermetia illucens*) dengan berbagai media. A*GROVITAL: Jurnal Ilmu Pertanian,* 5 (2): 91-93.

Sari, D., Putra, D.F., Nazlia, S., 2024. The Effect of Addition of Fermented Gamal Leaf Flour (*Gliricidia sepium*) in Feed on Seed Growth Freshwater Pomfret Fish (*Colossoma macropomum*). *Journal of Aquaculture Science*, 9, 30–38.

Supriyatna, A., A. A. Jauhari, D. Holydaziah. 2015. Aktivitas enzim amilase, lipase, dan protease dari larva *Hermetia illucens* yang diberi pakan jerami padi. *Jurnal Istek,* 9 (2): 18-32.

Suratno, S., & Putra, D. F. 2022. Pengendalian ektoparasit Pada ikan lele Sangkuriang (*Clarias gariepinus*) dengan konsentrasi oksigen terlarut sebagai faktor pembatas. *Jurnal Vokasi Ilmu-Ilmu Perikanan,* 2(4), 9–13.

Varianti, N. I., U. Atmomarsono, L. D. Mahfudz. 2017. Pengaruh pemberian pakan dengan sumber protein berbeda terhadap efisiensi penggunaan protein ayam lokal persilangan. *Agripet,* 17 (1): 53-59.

Wangni, G. P., S. Prayogo, Sumantriyadi. 2019. Kelangsungan hidup dan pertumbuhan benih ikan patin siam (*Pangasius hypophthalmus*) pada suhu media pemeliharaan yang berbeda. J*urnal Ilmu-Ilmu Perikanan Dan Budidaya Perairan,* 14 (2): 21-28.

Yanuar, V. 2017. Pengaruh pemberian jenis pakan yang berbeda terhadap laju pertumbuhan benih ikan nila (*Oreochiomis niloticus)* dan kualitas air di akuarium pemeliharaan. *Ziraa'Ah,* 42 (2): 91–99.