

THE EFFECT SUBSTITUTION OF FISH MEAL WITH FRESH BLACK SOLDIER FLY LARVA ON THE GROWTH AND HEALTH OF CATFISH (*Clarias* sp.)

Pengaruh Substitusi Tepung Ikan dengan Larva *Black Soldier Fly* Segar Terhadap Pertumbuhan dan Kesehatan Lele (*Clarias* sp.)

Lubnah Tanti Prihatini and Senny Helmiati*

Department of Fisheries, Faculty of Agriculture, Gadjah Mada University

Flora Street, Bulaksumur, Yogyakarta

*Corresponding Author: senny@ugm.ac.id

(Received June 10th 2026; Accepted August 6th 2026)

ABSTRACT

The aim of this research is to determine the effect of substituting fish meal with fresh Black Soldier Fly (BSF) larvae on the growth and health of catfish (*Clarias* sp.). The research was conducted with four treatments and triplicates using a completely randomized design. Treatment P1 is the substitution of 100% fish meal with 0% fresh BSF larvae, P2 is the substitution of 75% fish meal with 25% fresh BSF larvae, P3 is the substitution of 50% fish meal with 50% fresh BSF larvae, and P4 is the substitution of 25% fish meal with 75% fresh BSF larvae. The research used catfish fry measuring 9-12 cm and feeding with a dose of 3% based on fish biomass twice a day. Data analysis was conducted using variance analysis at a significance level of 95%. If the variance analysis results are significantly affected, further testing was conducted using the Duncan Multiple Range Test. The research results show that replacing 50% of fish meal with 50% fresh BSF larvae increases survival, growth, and blood haematocrit, while the feed conversion ratio decreases. Substituting 25% of fish meal with 75% fresh BSF larvae results in absolute growth performance and specific growth rate based on weight of catfish of 24.20 ± 0.94 g and $0.40 \pm 0.01\%$ per day, respectively. By replacing 50% of fish meal with fresh BSF larvae, survival and feed conversion ratio of catfish were obtained at $94.67 \pm 2.31\%$ and 1.2 ± 0.08 , respectively.

Keywords: Catfish, Fresh BSF larvae, Fish Meal, Growth

ABSTRAK

Tujuan dari penelitian ini adalah mengetahui pengaruh substitusi tepung ikan dengan larva *Black Soldier Fly* (BSF) segar terhadap pertumbuhan dan kesehatan lele (*Clarias* sp.). Penelitian dilakukan pada empat perlakuan dan tiga ulangan dengan menggunakan rancangan acak lengkap. Perlakuan P1 adalah substitusi tepung ikan 100% dengan larva BSF segar 0%, P2 adalah substitusi tepung ikan 75% dengan larva BSF segar 25%, P3 adalah substitusi tepung ikan 50% dengan larva BSF segar 50%, dan P4 adalah substitusi tepung ikan 25% dengan larva BSF segar 75%. Penelitian menggunakan benih lele berukuran 9-12 cm dan pemberian

pakan dengan dosis 3% berdasarkan biomassa ikan sebanyak dua kali sehari. Analisis data dilakukan menggunakan analisis varian pada tingkat signifikansi 95%. Apabila hasil analisis varian berpengaruh nyata, maka dilakukan uji lanjut menggunakan *Duncan Multiple Range Test*. Hasil penelitian menunjukkan bahwa dengan mengganti tepung ikan 50% dengan larva BSF segar 50% maka sintasan, pertumbuhan, dan hematokrit darah meningkat, sementara rasio konversi pakannya menurun. Substitusi tepung ikan 25% dengan larva BSF segar 75% menghasilkan performa pertumbuhan mutlak dan laju pertumbuhan spesifik berbasis berat lele masing-masing $24,20 \pm 0,94$ g dan $0,4 \pm 0,01\%$ per hari. Dengan mengganti 50% tepung ikan dengan larva BSF segar diperoleh sintasan dan rasio konversi pakan lele masing-masing sebesar $94,67 \pm 2,31\%$ dan $1,2 \pm 0,08$.

Kata Kunci: Larva BSF segar, Pertumbuhan, Tepung Ikan, Lele

INTRODUCTION

Feed accounts for 60–70% of production costs. High feed prices and poor feed quality can be detrimental to catfish farmers (Waluyo and Nugraha, 2020). Providing alternative feed is one way to reduce feed costs. Insects serve as an alternative feed source, possessing nutrient profiles similar to those of fish meal (Alfiko et al., 2021). Certain insects—such as silkworms, yellow mealworms, bamboo worms, banded crickets, and black soldier fly (BSF) larvae—are capable of converting waste into protein. BSF larvae can be utilized in waste processing and as an additive for fish feed (Alfiko et al., 2021). By using BSF larvae as an alternative protein source, the aquaculture industry can reduce costs without compromising quality (Wardhana, 2016).

The use of BSF larvae as a raw material for feed and a source of protein has been widely implemented. A diet consisting of 50% commercial feed and 50% BSF larvae can reduce feed costs by 22.74% (Fauzi and Sari, 2018). Substituting 50% of the feed with BSF larval meal results in a specific weight growth rate of up to 6.75%/day, a specific length growth rate of 2.65%/day, a survival rate of up to 97%, and a feed efficiency of 5.88 (Siagian, 2020). Berampu et al. (2021) reported that a combination of BSF larvae and commercial feed (at a 50:50 ratio) yields a survival rate of up to 100%, an absolute length growth of up to 3.58 cm, and a feed conversion ratio of 1.00. BSF larvae in powdered form command a relatively high price, whereas fresh BSF larvae have not yet been widely utilized in the formulation of artificial feeds. The purpose of this study is to determine how the substitution of fish meal with fresh Black Soldier Fly (BSF) larvae affects the growth and health of catfish (*Clarias* sp.).

RESEARCH METHODS

Place and Time

The research was conducted from March to May 2023 at the Fish Nutrition Sub-Laboratory, Aquaculture Laboratory, Department of Fisheries, Faculty of Agriculture, Universitas Gadjah Mada.

Tools and Materials

The equipment used includes fiber tanks, a water quality checker, an analytical balance, a digital scale, an electric oven, a desiccator, an electric stove, a muffle furnace, sieves, basins, and buckets. The materials used consist of 9–12 cm catfish fingerlings, fish meal, fresh BSF (Black Soldier Fly) larvae, soybean meal, rice bran, corn flour, tapioca starch, a mineral mix, vitamin C, and fish oil.

Research Design

This study employs a Completely Randomized Design with four treatments and three replications, consisting of:

P1: 100% fish meal: 0% fresh BSF larvae

P2: 75% fish meal : 25% fresh BSF larvae

P3: 50% fish meal : 50% fresh BSF larvae

P4: 25% fish meal : 75% fresh BSF larvae.

Formulation Development and Feed Production

Table 1 presents the test feed formulations, which were developed using the Pearson square method.

Table 1. Catfish feed formulations

Feed Ingredients	Treatment			
	TI 100%: LBSFS 0%	TI 75%: LBSFS 35%	TI 50%: LBSFS 50%	TI 25%: LBSFS 75%
Fish meal	42,50	31,88	21,25	10,62
Fresh BSF larvae	0,00	10,62	21,25	31,88
Soybean meal	21,24	21,24	21,24	21,24
Bran	10,63	10,63	10,63	10,63
Cornstarch	10,63	10,63	10,63	10,63
Starch	10,00	10,00	10,00	10,00
Mineral mix	2,50	2,50	2,50	2,50
Vitamin C	0,50	0,50	0,50	0,50
Fish oil	2,00	2,00	2,00	2,00
Total (%)	100	100	100	100

Description: TI (fish meal); LBSFS (fresh BSF larvae)

The feed production process begins by weighing all raw ingredients according to the feed formulation, followed by mixing the ingredients and adding an appropriate amount of hot water. The feed mixture is thoroughly blended and then fed into a pelletizing machine. The feed is shaped into pellets and dried in an oven at 45°C for 6–8 hours. Finally, it is stored in airtight plastic containers.

Preparation of Cultivation Containers

The rearing containers for catfish fry consist of 12 fiber tanks, each measuring 50x50x70 cm³. The tanks are cleaned by scrubbing their walls to prevent the growth of fungi and pathogenic bacteria. They are then soaked for 24 hours in water mixed with a potassium permanganate solution. Following this, the soaking water is drained, and the tanks are left to dry. Finally, the tanks are filled with water to a depth of 40–50 cm.

Stocking and Rearing of Catfish Fry

The stocking density for the catfish fry in each rearing container was 25 individuals. The fry used were healthy and uniform in size, with an average weight of 9.44 g and an average length of 11.14 cm. Before being stocked, the catfish fry underwent an acclimatization process to adjust to their new environment. Over a 60-day period, the fry were fed at a rate of 3% of their total biomass, with feedings provided twice daily at 08:00 and 15:00 WIB. The water was replaced every seven days. Throughout the rearing period, the growth of the catfish fry—specifically their length and weight—was monitored on days 0, 15, 30, 45, and 60. Water quality, as well as hematocrit and leukocrit levels, were measured on days 0, 30, and 60.

Observation Parameters

Survival rate

Survival can be calculated using the formula:

$$SR = \frac{N_t}{N_o} \times 100\%$$

Note :

SR : Survival rate (%)

Nt : Number of fish still alive at the end of maintenance (tail)

No : Number of fish alive at the start of maintenance (tail)

Absolute Growth

Absolute weight-based growth:

$$W = W_t - W_o$$

Note:

W : Absolute weight-based growth (g)

W_t : Fish weight at the end of the rearing period (g)

W_o : Fish weight at the start of rearing (g)

Absolute growth based on length:

$$L = L_t - L_o$$

Note:

L : Absolute growth based on length (cm)

L_t : Fish length at the end of the rearing period (cm)

L_o : Fish length at the start of the rearing period (cm)

Weight-Based Specific Growth Rate

The weight-based specific growth rate is calculated using the formula:

$$SGR = \frac{(\ln W_t - \ln W_o)}{T} \times 100\%$$

Note:

SGR : Weight-based specific growth rate (%/day)

W_t : Fish weight at the end of the rearing period (g)

W_o : Fish weight at the start of rearing (g)

T : Maintenance time (day)

Feed Conversion Ratio

FCR can be calculated using the formula:

$$FCR = \frac{F}{(W_t + D) - W_o}$$

Note:

FCR : Feed Conversion Ratio

F : Amount of feed consumed by fish (g)

W_t : Fish weight at the end of the rearing period (g)

D : Weight of the dead fish (g)

W_o : Fish weight at the start of rearing (g)

Hematocrit and Leukocrit Levels

$$\text{Hematocrit Level (\%)} = \frac{\text{Length of the erythrocyte sediment in a capillary tube}}{\text{Total length of blood cells and serum within the capillary}} \times 100\%$$

The leukocrit level is determined by measuring the lengths of the red blood cell and white blood cell layers within a microcapillary tube, then calculating the result as a percentage (%). To distinguish between erythrocytes, leukocytes, and plasma, the end of the hematocrit capillary tube containing the blood sample is sealed with sealing wax (virtex). The capillary tube is then centrifuged for five minutes at 3000 rpm. The leukocyte level is measured using a caliper, and its volume percentage is subsequently calculated.

$$\text{Leukocrit (\%)} = \frac{\text{Length of the leukocyte sediment in a capillary tube}}{\text{Total length of blood cells and serum within the capillary}} \times 100\%$$

Water Quality

The water quality parameters measured include water temperature, pH, dissolved oxygen, free CO₂, alkalinity, and ammonia. Water temperature, pH, and dissolved oxygen

were monitored using a water quality checker; free CO₂ and alkalinity were determined via color indicator methods, while ammonia was measured using reagent tests.

Data Analysis

Growth parameters—feed conversion ratio, hematocrit, and leukocrit—as well as survival data, were tested for normality and homogeneity. Once the data were confirmed to be normal and homogeneous, they were analyzed using analysis of variance (ANOVA) at a 95% confidence level. To determine significant differences between treatments, Duncan's Multiple Range Test was applied.

RESULT

According to SNI 9043-4:2022, catfish feed must contain a minimum of 30% protein, 5% fat, 8% crude fiber, a maximum of 13% ash, and a minimum of 12% moisture. Proximate analysis of the feed indicates that protein content ranges from 30.29±0.07% to 32.72±0.71%, fat from 8.68±0.9% to 12.50±0.02%, ash from 9.95±1.30% to 11.22±0.48%, moisture from 8.9±0.21% to 9.94±0.09%, carbohydrates from 35.17±0.00% to 41.45±0.00%, and crude fiber from 3.12±0.42% to 3.42±0.25%. The protein, fat, and ash levels meet the feed requirements stipulated by SNI 9043-4:2022. The crude fiber content in the test feed remains within the optimal range, as the values are below 10%. Mikdarullah et al. (2020) stated that the maximum crude fiber requirement for optimal fish growth is 10%. The energy content ranges from 3219±13.01 to 3392±87.312 kcal, which is close to the optimal value. The optimal energy requirement for catfish feed is 4000–5000 kcal (Syahrizal et al., 2020).

Table 2. Nutrient content of the test feed

Nutrient Content	Treatment			
	TI 100%: LBSFS 0%	TI 75%: LBSFS 25%	TI 50%: LBSFS 50%	TI 25%: LBSFS 75%
Protein (%)	30,29±0,07 ^a	30,3±0,95 ^a	31,85±2,65 ^a	32,72±0,71 ^a
Fat (%)	8,68±0,9 ^a	9,47±0,4 ^{bc}	10,62±0,81 ^c	12,50±0,02 ^d
Ash (%)	10,68±0,43 ^a	10,36±0,83 ^a	11,22±0,48 ^a	9,95±1,30 ^a
Water % (bk)	8,9±0,21 ^a	9,16±0,02 ^a	9,94±0,09 ^a	9,67±0,85 ^a
Carbohydrate %	41,45±0,00 ^b	40,71±0,00 ^b	36,38±0,00 ^a	35,17±0,00 ^a
Crude fiber %	3,12±0,42 ^a	3,36±0,27 ^a	3,18±0,07 ^a	3,42±0,25 ^a
Energy (kkal)	3361±63,34 ^{ab}	3219±13,01 ^a	3363±48,89 ^{ab}	3392±87,31 ^b

Description: The mean ± SD value followed by the same superscript letter in the same column indicates no significant difference ($p > 0.05$).

The survival rate of the catfish ranges from 85.33±2.31% to 94.67±2.31%, as shown in Table 3. Catfish fed a diet in which 50% of the fish meal was replaced with fresh BSF (Black Soldier Fly) larvae exhibited the highest survival rate, at 94.67±2.31%.

Table 3. Survival Rate

Treatment	Replication 1	Replication 2	Replication 3	Average (%)
TI 100%: LBSFS 0%	92,00	88,00	96,00	92,00±4,00 ^b
TI 75%: LBSFS 25%	88,00	92,00	92,00	90,67±2,31 ^b
TI 50%: LBSFS 50%	96,00	92,00	96,00	94,67±2,31 ^b
TI 25%: LBSFS 75%	88,00	84,00	84,00	85,33±2,31 ^a

Description: The mean $\pm$ SD value followed by the same superscript letter in the same column indicates no significant difference ($p > 0.05$).

Table 4 shows that substituting 50% of the fish meal with 50% fresh BSF larvae resulted in an absolute growth in length of 6.76 ± 0.32 cm, and specific growth rates based on length and weight of $0.11 \pm 0.01\%$ per day and $0.37 \pm 0.01\%$ per day, respectively. Substituting 25% of the fish meal with 75% fresh BSF larvae yielded the highest absolute growth in length and weight, as well as the highest specific growth rates for both length and weight, which were 7.21 ± 0.38 cm, 24.20 ± 0.61 g, $0.12 \pm 0.01\%/day$, and $0.40 \pm 0.01\%/day$, respectively.

Table 4. Absolute growth and specific growth rate of catfish

Parameter	Treatment			
	TI 100%: LBSFS 0%	TI 75%: LBSFS 25%	TI 50%: LBSFS 50%	TI 25%: LBSFS 75%
Absolute growth based on length (cm)	$5,63 \pm 0,26^a$	$5,45 \pm 0,19^a$	$6,76 \pm 0,32^b$	$7,21 \pm 0,38^b$
Absolute weight-based growth (g)	$20,00 \pm 0,62^a$	$20,56 \pm 0,67^a$	$22,33 \pm 0,78^a$	$24,20 \pm 0,61^b$
Length-based specific growth rate (%/day)	$0,09 \pm 0,01^a$	$0,09 \pm 0,00^a$	$0,11 \pm 0,01^b$	$0,12 \pm 0,01^b$
Weight-based specific growth rate (%/day)	$0,34 \pm 0,01^a$	$0,34 \pm 0,02^a$	$0,37 \pm 0,01^b$	$0,40 \pm 0,01^b$

Description: The mean $\pm$ SD value followed by the same superscript letter in the same column indicates no significant difference ($p > 0.05$).

Table 5 shows that the feed conversion ratio for catfish fed diets in which fish meal was substituted with fresh BSF larvae ranges from 1.20 ± 0.08 to 1.39 ± 0.08 .

Table 5. Feed conversion ratio

Treatment	Replication 1	Replication 2	Replication 3	Average
TI 100%: LBSFS 0%	1,41	1,30	1,45	$1,39 \pm 0,08^b$
TI 75%: LBSFS 25%	1,27	1,32	1,36	$1,32 \pm 0,05^{ab}$
TI 50%: LBSFS 50%	1,20	1,28	1,12	$1,20 \pm 0,08^a$
TI 25%: LBSFS 75%	1,13	1,26	1,24	$1,21 \pm 0,07^a$

Description: The mean $\pm$ SD value followed by the same superscript letter in the same column indicates no significant difference ($p > 0.05$).

Table 6 shows that the rearing of catfish, with a diet in which fish meal is substituted with fresh BSF larvae, results in hematocrit levels ranging from $19.47 \pm 2.08\%$ to $23.23 \pm 1.76\%$ and leukocrit levels ranging from $1.48 \pm 0.01\%$ to $1.81 \pm 0.28\%$.

Table 6. Hematocrit and Leukocrit Levels

Treatment	Hematokrit	Leukokrit
TI 100%: LBSFS 0%	$19,75 \pm 2,01^{ab}$	$1,65 \pm 0,28^a$
TI 75%: LBSFS 25%	$19,47 \pm 2,08^{ab}$	$1,81 \pm 0,28^a$
TI 50%: LBSFS 50%	$23,23 \pm 1,76^b$	$1,48 \pm 0,01^a$
TI 25%: LBSFS 75%	$23,06 \pm 0,86^b$	$1,76 \pm 0,25^a$

Description: The mean $\pm$ SD value followed by the same superscript letter in the same column indicates no significant difference ($p > 0.05$).

Table 7 shows that in the rearing of catfish, where fish meal in the feed was substituted with fresh BSF (Black Soldier Fly) larvae, the water parameters were as follows: temperature ranged from 26.7 ± 0.19 °C to 26.71 ± 0.18 °C, pH ranged from 7.13 ± 0.08 to 7.17 ± 0.07 , dissolved oxygen levels ranged from 3.34 ± 0.15 to 3.36 ± 0.16 mg/L, and ammonia levels ranged from 0.013 ± 0.011 to 0.02 ± 0.019 mg/L. The data indicate that the water quality parameters throughout the rearing period remained within standard ranges.

Table 7. Water quality during the rearing period

Parameter	Treatment				Standar
	TI 100%: LBSFS 0%	TI 75%: LBSFS 25%	TI 50%: LBSFS 50%	TI 25%: LBSFS 75%	
Temperature (°C)	$26,71 \pm 0,18$	$26,7 \pm 0,03$	$26,71 \pm 0,02$	$26,7 \pm 0,19$	25-30 ^a
pH	$7,17 \pm 0,07$	$7,16 \pm 0,05$	$7,13 \pm 0,08$	$7,13 \pm 0,08$	6,5-8 ^a
Dissolved oxygen (mg/l)	$3,35 \pm 0,16$	$3,35 \pm 0,04$	$3,34 \pm 0,15$	$3,36 \pm 0,16$	$\geq 3^a$
Free CO ₂ (mg/l)	$48,73 \pm 15,54$	$51,33 \pm 16,34$	$49,33 \pm 15,33$	$50,27 \pm 12,3$	10-60 ^b
Alkalinity (mg/l)	$356,00 \pm 125,00$	$62,00 \pm 132,00$	$371,00 \pm 137,00$	$360,00 \pm 139,0$	200-500 ^c
Ammonia (mg/l)	$0,017 \pm 0,016$	$0,02 \pm 0,019$	$0,015 \pm 0,014$	$0,013 \pm 0,011$	$\leq 0,1^a$

Note: (a) According to SNI (2014); (b) Tarkus et al. (2014); (c) Utami and Herdiana (2021)

DISCUSSION

During the rearing period, the fish responded well to the feed, ensuring that the rearing environment remained free from excessive feed residue while providing a balanced supply of nutrients for the catfish. A higher substitution rate of fresh BSF (Black Soldier Fly) larvae in the feed led to an increased fat content in the fish, as fresh BSF larvae contain higher levels of fat compared to fish meal. The treatment involving a 75% substitution of fish meal with fresh BSF larvae resulted in both a higher fat content and the greatest absolute weight gain. Fat that is not utilized for energy is stored within the fish's body. There is a positive correlation between the fat content in the feed and the amount of fat accumulated in the fish's body (Berampu et al., 2021).

The treatment with a 25% substitution of fish meal with fresh BSF larvae showed a lower growth rate compared to the other treatments. This is likely due to a less balanced nutrient profile in the feed, which resulted in a poorer response from the fish and, consequently, slower growth. The amino acid composition of the feed determines its protein quality, which in turn influences fish growth; feed containing a combination of two protein sources is superior to feed relying on only one (Berampu et al., 2021). Furthermore, fish growth is also influenced by the fat content in the feed. When the fat level aligns with the fish's requirements, it can be utilized as an energy source for metabolic activities, thereby allowing protein to be more effectively directed toward growth (Yustiati et al., 2020).

A low feed conversion ratio suggests that the nutrients provided were utilized more efficiently than in the other treatments. This further indicates that substituting fish meal with fresh BSF larvae leads to improved growth. Replacing fish meal with fresh BSF larvae at levels of 50%–75% can result in cost savings of approximately 7.75%–14.15% per kilogram of feed, compared to a scenario with 0% BSF larvae substitution (i.e., 100% fish meal). Nurhuda et al. (2019) state that normal hematocrit values range from 20–45%, while leukocrit values range from 1–2%. Measuring hematocrit is one method for assessing fish health, as it serves as an

indicator of stress levels. Potential stressors include environmental factors, blood sampling procedures (injections), and pathogen infections.

Hematocrit levels vary based on factors such as nutrition, age, sex, body size, and the spawning period (Pratiwi et al., 2019). A leukocrit level below 1% may be attributed to poor nutrition, vitamin deficiencies, or the presence of contaminants. Conversely, a leukocrit level exceeding 2% may indicate that the fish is experiencing stress (Nurhuda et al., 2019).

CONCLUSION

Replacing 50% of the fish meal with 50% fresh BSF (Black Soldier Fly) larvae improves survival, growth, and blood hematocrit levels, while also lowering the feed conversion ratio in catfish. A substitution of 25% fish meal with 75% fresh BSF larvae results in an absolute growth performance of 24.20 ± 0.94 g and a weight-based specific growth rate of $0.4 \pm 0.01\%$ /day for the catfish. Replacing 50% of the fish meal with 50% fresh BSF larvae yields a survival rate of $94.67 \pm 2.31\%$ and a feed conversion ratio of 1.2 ± 0.08 for the catfish.

ACKNOWLEDGEMENT

The author expresses gratitude to the Faculty of Agriculture, Universitas Gadjah Mada, for funding this research through the Lecturer-Student Collaborative Research Grant.

REFERENCES

- Alfiko, Y., Xie, D., Astuti, R. A., Wong, J., & Wang, L. (2021). Insects as a Feed Ingredient for Fish Culture: Status and Trends. *Journal Aquaculture and Fisheries*, 7(2), 166-178. <https://doi.org/10.1016/j.aaf.2021.10.004>
- Berampu, L. E., Patriono, E., & Amalia, R. (2021). Pemberian Kombinasi Maggot (*Hermetia illucens*) dan Pakan Komersial untuk Efektifitas Pemberian Pakan Tambahan Benih Ikan Lele Sangkuriang (*Clarias gariepinus*) oleh Kelompok Pembudidaya Ikan Lele. *Sriwijaya Bioscientia*, 2(2), 1-15. <https://doi.org/10.24233/sribios.2.2.2021.315>
- Fauzi, R. U. A., & Sari, E. R. N. (2018). Analisis Usaha Budidaya Maggot sebagai Alternatif Pakan Lele. *Jurnal Teknologi dan Manajemen Agroindustri*, 7(1), 39-46. <https://doi.org/10.21776/ub.industria.2018.007.01.5>
- Mahendra, I. P. E., Arthana, I. W., & Dewi, I. P. W. K. (2022). Pengaruh Pemberian Pakan Berbeda pada Laju Pertumbuhan Ikan Lele Dumbo (*Clarias gariepinus*). *Jurnal Bumi Lestari*, 22(1), 12-19. <https://doi.org/10.24843/blje.2022.v22.i01.p02>
- Mikdarullah, Nugraha, A., & Khazaidan. (2020). Analisis Proksimat Tepung Ikan dari Beberapa Lokasi yang Berbeda. *Bulletin Teknik Litkayasa Akuakultur*, 18(2), 133-138. <http://dx.doi.org/10.15578/blta.18.2.2020.133-138>
- Nurhuda, M., Kholista, M. A., Ismi, Y., Maulidiya, N., Hariyadi, & Hakim, R. R. (2019). Effectiveness of Cherry Leaf Extract (*Muntingia calabura*) with Different Levels as Treatment of Seeds of Sangkuriang Catfish (*Clarias gariepinus*) Infected by Trichodina sp. *Indonesian Journal of Tropical Aquatic*, 1(1), 41-49. <https://doi.org/10.22219/ijota.v1i1.5980>
- Pratiwi, V. A., Eddiwan, & Efawani. (2019). Studi Kondisi Darah Ikan Lele Lokal (*Clarias batrachus*) di Sungai Tapung Kiri dan Sungai Sail Provinsi Riau. *Skripsi*. Fakultas Perikanan dan Klautan, Universitas Riau.
- Prasetya, D. (2011). *Bisnis Benih Lele Untung 200%*. Penebar Swadaya. Bogor. Diakses pada 26 Juni 2023.
- Standar Nasional Indonesia. (2006). *Pakan Buatan untuk Ikan Lele (Clarias gariepinus)*. SNI: 01-4087-2006. Jakarta: SNI. 1-12 hlm.
- Standar Nasional Indonesia. (2014). *Produksi Induk Ikan Lele Dumbo (Clarias sp.)*. SNI: 6484.3:2014. Jakarta: SNI. 1-9 hlm.

- Standar Nasional Indonesia. (2022). *Pakan Buatan Bagian 4: Ikan lele (Clarias spp.)* sebagai revisi dari SNI 01-4087-2006 tentang Pakan buatan untuk Ikan Lele Dumbo (*Clarias gariepinus*) pada budidaya intensif. 1-48 hlm.
- Siagian, G. (2020). Pengaruh Pemberian Larva Black Soldier fly (*Hermetia illucens*) terhadap Pertumbuhan Ikan Lele Dumbo (*Clarias gariepinus*). *International Journal of Natural Sciences and Engineering*, 4(2), 83-91. <https://doi.org/10.23887/ijnse.v4i2.29369>
- Sugianti, E. P., & Hafiludin. (2022). Manajemen Kualitas Air pada Pembenihan Ikan Lele Mutiara (*Clarias gariepinus*) di Balai Benih Ikan (BBI) Pamekasan. *Jurnal Trunojoyo*, 3(2), 32-36. <https://doi.org/10.21107/juvenil.v3i2.15813>
- Syahrizal, Sugihartono, M., & Jasa, A. (2019). Respon Ikan Lele Dumbo (*Clarias gariepinus*, B) dalam Wadah Jaring Hapa yang Diberi Pakan Kombinasi Pellet dan Usus Ayam. *Jurnal Akuakultur Sungai dan Danau*, 4(2), 50-59. <https://doi.org/10.33087/akuakultur.v4i2.56>
- Tarkus, A., Hasibuan, S., & Pamukas, N. A. (2014). Type and Abundance of Phytoplanktons and Absorptions of Ammonia on African Catfish (*Clarias gariepinus*) Cultivation, Differences of Stoking Density with Bioflok. *Jurnal Online Mahasiswa*, 1(2), 1-11.
- Utami D. P., & Herdiana I. N. (2021). Pengukuran Kualitas Sumber Air Media Pemeliharaan Ikan di Balai Riset Pemuliaan Ikan. *Buletin Teknik Litkayasa Akuakultur*, 19(1), 19-24. <http://dx.doi.org/10.15578/blta.19.1.2021.19-24>
- Waluyo, B. P. & Nugraha, J. P. (2020). Analisis Usaha Pembesaran Lele dengan menggunakan Pakan Tambahan Maggot Black Soldier Fly (BSF) di UPR Christanto Darmawan Yogyakarta. *Jurnal Chanos chanos*, 1(1), 19-27.
- Wardhana, A.H. (2016). Black Soldier Fly (*Hermetia illucens*) sebagai Sumber Protein Alternatif untuk Pakan Ternak. *Wartazoa*, 26(2), 69-78. <http://dx.doi.org/10.14334/wartazoa.v26i2.1218>.
- Yustiati, A., Habibie, M. R., Haetami, K., & Suryadi, I. B. (2020). Growth Performance of Mutiara Catfish (*Clarias gariepinus*) Feed a Combination of Commercial Feed and Black Soldier Fly Maggot (*Hermetia illucens*). *Asian Journal of Fisheries and Aquatic Research*, 9(4), 27-36. DOI: 10.9734/ajfar/2020/v9i430168