Jurnal Akuakultur Indonesia
OPEN ACCESS
ISSN: 1412-5269
EISSN: 2354-6700
Vol. 25 No. 1, January 2026
DOI: 10.19027/jai.25.1.81-91

Replacing silkworms *Tubifex* sp. with fermented paste feed enriched with curcumin on Asian redtail catfish *Hemibagrus nemurus* larvae growth

Penggantian cacing sutera dengan pakan pasta terfermentasi yang diperkaya kurkumin terhadap pertumbuhan postlarva ikan baung *Hemibagrus nemurus*

Benny Heltonika[1*], Netti Aryani[1], Nur Asiah[1], Indra Lesmana[1], Nuraini Nuraini[1], Firman Theodali Harefa[2]

[1]Department of Aquaculture, Faculty of Fisheries and Marine Science, Pekanbaru, Riau, Riau University, Indonesia
[2]Student of Aquaculture Department, Faculty of Fisheries and Marine Science, Pekanbaru, Riau, Riau University, Indonesia
*Corresponding author: benny.heltonika@lecturer.unri.ac.id

(Received November 22, 2024; Revised February 14, 2025; Accepted August 28, 2025)

ABSTRACT

To maintain growth and survival, Asian redtail catfish postlarvae require silkworms as live food. However, due to their extreme sensitivity to natural conditions, silkworms will be exceedingly scarce during the rainy season. This study aimed to evaluate fermented commercial feed enriched with curcuminas replacement of silkworms for the growth and survival of redtail catfish postlarvae. This study employed a complete design experiment consisting of six treatments: P1 (non-fermented commercial feed), P2 (no curcumin-enriched fermented commercial feed), P3 (curcumin-enriched fermented commercial feed at 0.35 g/kg), P4 (curcumin-enriched fermented commercial feed at 0.70 g/kg), P5 (curcumin-enriched fermented commercial feed at 1.05 g/kg), and P6 (silkworms). Each treatment was replicated four times. The Asian red tail catfish postlarvae, measuring 0.63 ± 0.05 mm in length, were cultivated at a density of 5 fish/L. Fish were raised for a period of thirty days. Growth in total weight, total length, specific weight rate, specific length rate, and survival rate of postlarvae were the parameters measured. The growth evaluation results indicate that substituting silkworm feed with fermented feed supplemented with curcumin at a concentration of 1.05 g/kg resulted in growth of 6.66% (length) and 14.29% (weight) lower than the silkworm treatment (P<0.01). Despite this decline, it represents the most effective outcome in this study, highlighting the potential of fermented feed where enrichment with curcumin as an alternative to silkworms for Asian redtail catfish larvae nutrition. In conclusion, curcumin-enriched fermented feed can promote the growth of Asian redtail catfish postlarvae.

Keywords: curcumin, fermented feed, silkworm, growth

ABSTRAK

Untuk mempertahankan pertumbuhan dan kelangsungan hidup, postlarva ikan baung membutuhkan cacing sutra sebagai makanan hidup. Namun, cacing sutera sangat sensitivitas terhadap kondisi alam, cacing sutra akan sangat langka selama musim penghujan. Penelitian ini bertujuan untuk mengevaluasi pakan komersial terfermentasi yang di perkarya kurkumin. Penelitian ini merupakan eksperimen dengan acak lengkap satu faktor yang terdiri dari enam perlakuan: yaitu P1 (Pakan komersial non-fermentasi), P2 (pakan komersial fermentasi yang diperkaya kurkumin), P3 (pakan komersial fermentasi yang diperkaya kurkumin pada 0,35 g/kg), P4 (pakan komersial fermentasi yang diperkaya kurkumin pada 0,70 g/kg), P5 (pakan komersial fermentasi yang diperkaya kurkumin pada 1,05 g/kg), dan P6 (cacing sutra). Setiap perlakuan diulang empat kali. Postlarva ikan baung, berukuran panjang 0,63 ± 0,05 mm, dibudidayakan pada kepadatan 5 ekor/L. Ikan dipelihara selama tiga puluh hari. Parameter yang diukur dalam penelitian ini adalah pertumbuhan berat total, panjang total, rata-rata pertumbuhan bobot, dan panjang spesifik serta kelulushidupan. Berdasarkan hasil evaluasi pertumbuhan menunjukkan pergantian pakan cacing sutera dengan pakan fermentasi yang diperkaya kurkumin 1,05 g/kg pakan menghasilkan pertumbuhan 6,66 % (panjang) dan 14,29% (berat) lebih rendah dari perlakuan cacing sutra (P<0,01), dan ini melrupakan hasil terbaik dari penelitian ini dalam upaya mencari pengganti pakan alternatif cacing sutera untuk postlarva ikan baung. Sebagai kesimpulan, pakan pasta terfermentasi yang diperkaya kurkumin dapat meningkatkan perkembangan postlarva ikan baung.

Kata kunci: kurkumin, pakan terfermentasi, cacing sutera, pertumbuhan

INTRODUCTION

The success of Asian redtail catfish cultivation is greatly influenced by the results of the Asian redtail catfish hatchery both in terms of quality and quantity of postlarvae. Several studies have revealed that the optimal initial feed for the growth of Asian redtail catfish was silkworm (Tubifidae) (Heltonika & Karsih, 2017; Syafitra *et al.,* 2018; Mudlofdar *et al.,* 2021; Sukmawati *et al.,* 2022; Cahyanurani *et al.,* 2023). However, insights gathered from interviews and observations with fish breeders and silkworm suppliers indicate that the accessibility of silkworms is contingent upon natural circumstances. Specifically, their availability becomes more restricted during the rainy season. Therefore, it is necessary to try alternative feed to replace silkworms as Asian redtail catfish larvae feed.

Heltonika *et al.* (2022a) state that fermented commercial feed (28% protein) could replace 70% of silkworms in terms of growth and survival of Asian redtail catfish. Therefore, studies are needed to improve the performance of fermented feed as a substitute of silkworms for Asian redtail catfish larvae. Potential strategies for optimizing the utilization of fermented commercial feed for Asia redtail catfish postlarvae include augmenting the protein content and incorporating natural constituents that promote feed utilization, such as curcumin. Enrichment of curcumin in silkworms promotes the development of climbing perch larvae (Heltonika *et al.,* 2016). Similarly, Hasby *et al.* (2022) find that enriching silkworms with turmeric flour high in curcumin could enhance the growth of Asian redtail catfish larvae. In addition, curcumin administration has been found to enhance immunity in juvenile Wuchang bream (Xia *et al.,* 2015) through the mitigation of stress-induced effects (Akdemir *et al.,* 2016).

The inclusion of curcumin in commercial diet has been found to enhance the survival and growth of Asian redtail catfish seeds measuring 5 cm in length (Heltonika, 2022). In this study, fermented feed was supplemented with varying amounts of curcumin. This study aimed to assess the impact of fermented feed enhanced with curcumin on the growth performance of Asian redtail catfish.

MATERIALS AND METHODS

Research time and place

This study was conducted from August to September 2023. Spawning, larval rearing, and parameter analysis were carried out in the Fish Breeding and Hatchery Laboratory of the Faculty of Fisheries and Marine Science, University of Riau.

Experimental design

This study was conducted using a complete design experiment with six treatments and four replications of each treatment. The treatments in this study were feeding Asian redtail catfish larvae with different feed specification, i.e., P1 (commercial feed, non-fermented paste), P2 (commercial fermented paste feed without curcumin enrichment), P3 (commercial fermented paste feed, enriched with 0.35 g curcumin/kg feed), P4 (curcumin enrichment of commercial fermented paste feed at 0.70 g/kg feed), P5 (curcumin enrichment of commercial fermented paste feed at 1.05 g/kg feed), P6 (silkworms).

Research procedure

Postlarvae and feed preparation

Postlarvae of Asian redtail catfish was obtained from hatchery, from one to three days after hatched, postlarvae rared in hatching incubation. When the postlarvae were four days after hatched, they were ready to be transferred into research media. The fermented feed used commercial feed paste with 38%, to made fermented feed, 6 mL of EM4 product fermenter (Laheng *et al.,* 2020; Heltonika *et al.,* 2022a). Contain of EM4 are Lactic Acid Bacteria *Lactobacillus* sp., Photosynthetic Bacteria *Rhodopseudomonas* sp., *Actinomycetes* sp., *Streptomyces* sp., as well as yeast and cellulose decomposing fungi (Telaumbanua *et al.,* 2023) and then activated of EM4 by mixing 6 mL of sweetened milk evenly and 60 mL of distilled water for 24 hours. After 24 hours taken 10 mL/kg fermentor was added of feed, and water was added to the dough until it did not break when held.

The feed was then placed in a jar and firmly closed for two days until it smelled of fermentation, this indicates that the fermentation process was successful. Fermented feed can be added with curcumin according to the specified dosage. The fermented feed was then maintained in the refrigerator during the research to maintain the feed's quality (Heltonika *et al.,* 2022a). The results of proximate analysis, amino acid, and fatty acid composition in commercial feed material prior to and subsequent to fermentation are as follows (Table 1). In contrast, the proximate analysis of silkworms pertains to the findings of

Herawati *et al.* (2016) concerning the control treatments. Fermented commercial feed exhibited a rise in crude protein content and relatively stable fat content, but a decline in crude fiber and carbohydrate content when compared to commercial feed that is not fermented.

The results of amino acid and fatty acid of fermented and non-fermented feed presented in Table 2, indicate that fermentation led to an increase in the concentrations of nearly all amino acids. These amino acids include lysine, cysteine, glutamic acid, serine, glycine, histidine, arginine, alanine, proline, tyrosine, valine, methionine, and aspartic acid. However, subsequent to fermentation, only Threonine decreased. Conversely, the concentrations of virtually all fatty acids, including capric, lauric, myristic, palmitic, oleic, and linolenic decreased. It was only linoleic and stearic fatty acids that encountered an increase.

The results of physical observations of feed after and before fermentation are presented in Table 3. The structure of fermented feed undergoes a transformation, becoming physically

Table 1. Nutrient content of fermented paste, non-fermented commercial feed paste, and silkworms.

Composition	Crude Proteins (%)	Crude fat (%)	Carbohydrate (%)	Crude Fiber (%)	Ash (%)
Commercial Feed before fermentation	36.74	9.03	33.31	4.01	12.74
Commercial Feed after fermentation	37.88	9.04	32.27	2.94	13.20
Silkworms (Herawati *et al.,* 2016)	56.11	8.62	18.90	8.55	7.82

Table 2. Amino acid and fatty acid content on fermented and non-fermented commercial feed.

Amino acid	Non-fermented feed (%)	Fermented feed (%)	Fatty acids	Non-fermented feed (%)	Fermented feed (%)
Aspartic Acid	1.53	1.83	Capric	Ni	Ni
Glutamic Acid	2.30	2.64	Lauric	0.05	0.09
Serine	0.65	0.87	Myristic	4.08	3.60
Glycine	0.56	0.73	Palmitic	30.95	28.52
Histidine	0.60	0.75	Stearic	1.17	1.90
Arginin	0.74	0.95	Oleic	57.37	56.23
Threonine	0.52	0.49	Linoleic	3.96	5.08
Alanine	0.66	0.78	Linolenic	0.51	0.40
Proline	0.59	0.63			
Tyrosine	0.40	0.57			
Valine	0.56	0.77			
Methionine	0.33	0.55			
Cysteine	0.47	0.62			
Isoleucine	0.82	1.10			
Leucine	1.20	1.47			
Phenylalanine	0.87	0.98			
Lysine	1.16	1.23			

Note: Ni (Not Identified).

Table 3. Physical form and smell of feed paste.

Treatment	Structure	Fragrance
Fermented Feed	Feels very soft and smooth	Scented sour
Non-fermented Feed	Feels rough	Smells fishy

gentler and smoother, whereas the structure of non-fermented feed undergoes a transformation, becoming physically coarser. The odor that results from the fermentation process becomes sour.

Experimental procedure

Asian redtail catfish postlarvae, with a length of 0.63 ± 0.05 mm and weight of 0.0023 ± 0.0004 g were cultivated in 24 aquariums where size each them was 40×25×35 cm^3, water volume was 20 L/aquarium than aeration added to each aquarium. The stocking density of postlarvae was 5 L. The feeding during the experiment was carried out with a satiation method, with a frequency of four times per day. The experiment was done for thirty days. Taking samples of postlarvae to measure length and weight, 30 fish were taken per container at each sampling. To water maintenance from feces and residual feed is vacuumed daily, and water is changed by 10–30% each morning. Water quality monitoring (temperature, pH, DO) are measured every three days.

Observation parameters

In evaluating this experiment were utilized growth in total weight, total length, specific growth rate, and survival rate. Weight and length data were measured at the start and final of the study. Total weight was calculated to determine the total weight gain of fish during rearing with this formula:

$$Wm = Wt - Wo$$

Note:
Wm = Absolute weight (g)
Wt = Average weight at the end of the study (g)
Wo = Average weight at the start of the study (g)

The total length growth was calculated to determine the increase in fish length during rearing with this formula:

$$Lm = Lt - Lo$$

Note:
Lm = Absolute length growth
Lt = Final average length
Lo = Initial average length

The specific growth rate was calculated by this formula (Akbarurrasyid *et al.,* 2021):

$$SGR = \left(\frac{(\text{Ln } Wt - \text{Ln } W0)}{t}\right) \times 100$$

Note:
SGR = Specific growth rate (%/day)
Wt = Average fish weight over time (g)
Wo = Mean weight of fish at the beginning of rearing (g)
t = Length of experiment (days)

The specific length rate was calculated by this formula (Akbarurrasyid *et al.,* 2021):

$$SLR\ (\%/day) = \frac{LnLt - LnL0}{t} \times 100$$

Note:
SLR = Specific length rate (%/day)
Lt = Average length of fish at time (cm)
Lo = Average length of fish at the beginning of rearing (cm)
t = Length of experiment (days)

The ability of feed to replace silkworms in weight growth (RW) is determined by the formula (Heltonika *et al.,* 2023c):

$$RW(\%) = \frac{\text{absolute weight growth value of the treatment} - i}{\text{absolute weight growth value by administering silkworms}} \times 100$$

The ability of feed to replace silkworms in length growth (RL) is determined by the formula (Heltonika *et al.,* 2023c):

$$RL(\%) = \frac{\text{absolute length growth value of the treatment} - i}{\text{absolute length growth value by administering silkworms}} \times 100$$

The number of opportunities for fish to survive after 30 days of rearing is referred to as survival. The survival was calculated using the formula:

$$\text{Survival rate } (\%) = \frac{\text{Number of live fishes at the end}}{\text{Number of live fishes at initial}} \times 100$$

Dissolved oxygen (DO) and pH measurements of rearing water were conducted at seven-day intervals, whereas temperature assessments

were conducted daily on each rearing medium. Dissolved oxygen concentration was measured using DO meter, pH was assessed employing a pH meter, and temperature in each tank was monitored using a thermometer.

Data analysis

The analysis of the data of growth in total weight, total length, specific growth rate, and survival rate used analysis of variance (ANOVA) was conducted utilizing the SPSS program, with a 99% confidence interval. Duncan's further test was conducted if the results of the analysis of variance were significantly different. The value of RW, RL, and water quality is only described according to the results obtained.

RESULTS AND DISCUSSION

Results

The measurement results of test parameters for treatments using fermented feed enriched with curcumin on the growth performance of Asian redtail catfish (*Hemibagrus nemurus*) postlarvae are presented in Table 4. The findings presented in Table 4 indicate that the absolute weight growth values vary from 0.18 ± 0.01 to 0.15 ± 0.01 g, the specific weight growth values span from 14.56 ± 0.02 to 16.77 ± 0.11%, and the absolute length growth values range from 1.39 ± 0.01 to 3.00 ± 0.03 cm. The specific length growth values range from 3.90 ± 0.02 to 5.86 ± 0.03‰. Notably, silkworms exhibited the highest growth rate, while unfermented control (P<0.01) resulted in the lowest growth rates. The ability of feed to replace silkworms in weight growth (RW) and length growth (RL) ranges from 51.43 to 85.71% and 46.33 to 97.33‰, respectively. The weight growth pattern of Asian redtail catfish postlarvae at a rate of 10 days is illustrated in Figure 1.

The graphic pattern indicates that the weight growth of Asian redtail catfish postlarvae has varied from day one to day thirty, with no discernible variation during the initial ten days. Postlarvae that were fed silkworms continued to yield consistently higher body weight values. The weight performance of Asian redtail catfish postlarvae is enhanced when fed fermented feed as opposed to unfermented feed, as shown in Table 5 and Figure 1. Additionally, the weight growth of these fish is positively impacted by the administration of curcumin. Curcumin added to fermented feed increases weight gain of fish, where treatment P6 (silkworms) is the best treatment. The above pattern of values was also consistent with the specific growth rate (P<0.01).

Based on the comparison of weight growth values, it is known that the ability of P5 (Fermented Commercial Feed Curcumin Enrichment Paste 1.05 g/kg feed) in replacing P6 (silkworms) is 85.71% and is the best treatment when compared with other treatments (treatments P1 to P4). The growth pattern of Asian redtail catfish postlarvae in terms of length per 10 days is also illustrated in Figure 2. The graphic pattern illustrates a discernible variation in the length development of Asian redtail catfish postlarvae from day one to day thirty, which has persisted since the initial ten days. In certain environments, silkworm-fed larvae continue to exhibit the greatest body length values. In contrast to unfermented feed, fermented feed promotes greater length development in Asian redtail catfish postlarvae, as shown in Table 5 and Figure 2. Furthermore, the administration

Table 4. The effect of fermented feed enriched with curcumin on the growth of Asian redtail catfish postlarvae (*Hemibagrus nemurus*).

Treatments	Absolute weight growth (g)	Specific weight growth (%/day)	Absolute length growth (cm)	Specific length growth (%/day)	RW (%)	RL (%)
P1	0.18 ± 0.01^{a}	14.56 ± 0.02^{a}	1.39 ± 0.01^{a}	3.90 ± 0.02^{a}	51.43	46.33
P2	0.21 ± 0.01^{b}	15.10 ± 0.10^{b}	1.94 ± 0.02^{b}	4.71 ± 0.02^{b}	60.00	64.67
P3	0.24 ± 0.01^{c}	15.45 ± 0.08^{c}	2.16 ± 0.02^{c}	4.98 ± 0.03^{c}	68.57	72.00
P4	0.28 ± 0.02^{d}	16.05 ± 0.24^{d}	2.80 ± 0.02^{d}	5.67 ± 0.02^{d}	80.00	93.33
P5	0.30 ± 0.01^{d}	16.22 ± 0.07^{d}	2.92 ± 0.05^{e}	5.78 ± 0.05^{e}	85.71	97.33
P6	0.35 ± 0.01^{e}	16.77 ± 0.11^{e}	3.00 ± 0.03^{f}	5.86 ± 0.03^{f}	100.00	100.00

Note: RW (treatment provided with food is able to replace the weight growth of silkworms), RL (treatment provided with food is able to replace the growth in length of silkworms); Different superscripts in the same column indicate significant differences (P<0.01).

of curcumin has been observed to have a positive impact on this parameter, where treatment P6 (silkworms) is the best treatment.

Discussion

According to the findings of this study, fermented paste feed can enhance the growth of Asian redtail catfish postlarvae in terms of weight growth, length growth, specific weight growth, and specific length growth (P<0.01). Fish growth can be stimulated by the byproducts of fermentation (Aliyu-A *et al.,* 2019; Anis & Hariani, 2019; Laheng *et al.,* 2020; Kinayungan & Helmiati, 2021; Siagian *et al.,* 2022). Complex organic molecules are broken down into simpler ones via the fermentation process, which is carried out by microorganisms (Danu *et al.,* 2016; Sharma *et al.,* 2020; Maicas, 2020). An increase in protein value and a reduction in crude fiber provide support for this. While this protein increase contradicts the findings of Heltonika *et al.* (2022a), whose research focused on fermenting feed and observed a decline in protein content subsequent to fermentation, crude fiber content also decreased, which aligns with the results of the present study that similarly reported improved growth values. Different varieties of fermenters were utilized; in this study, the EM4 fermenter was applied to livestock, whereas Heltonika *et al.* (2022a) applied the same method to agriculture.

Variations in the feed's amino acid and fatty acid content have an impact on the growth performance enhancement of Asian redtail catfish postlarvae that are fed fermented paste. Additionally, the fish's preference and behavior regarding feed are impacted by physical changes in the feed. This impacts the fish's digestive capacity and contributes to the reduction of antinutrients

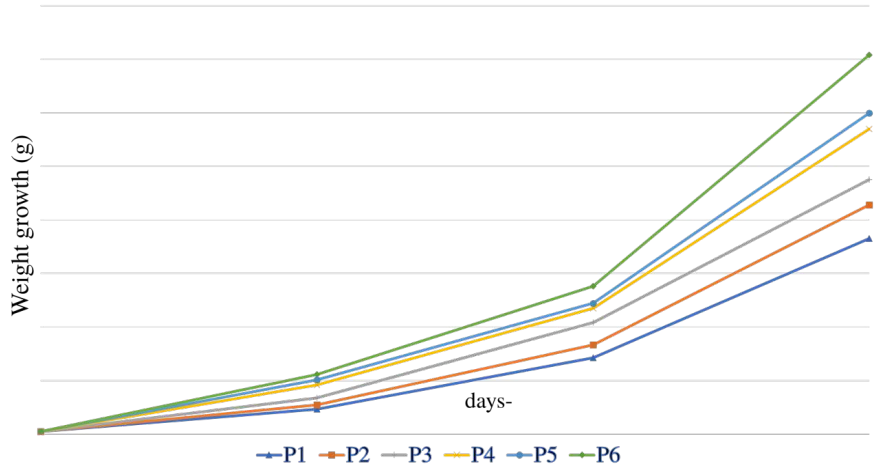

Figure 1. Weight growth pattern of Asian redtail catfish postlarvae per 10 days.

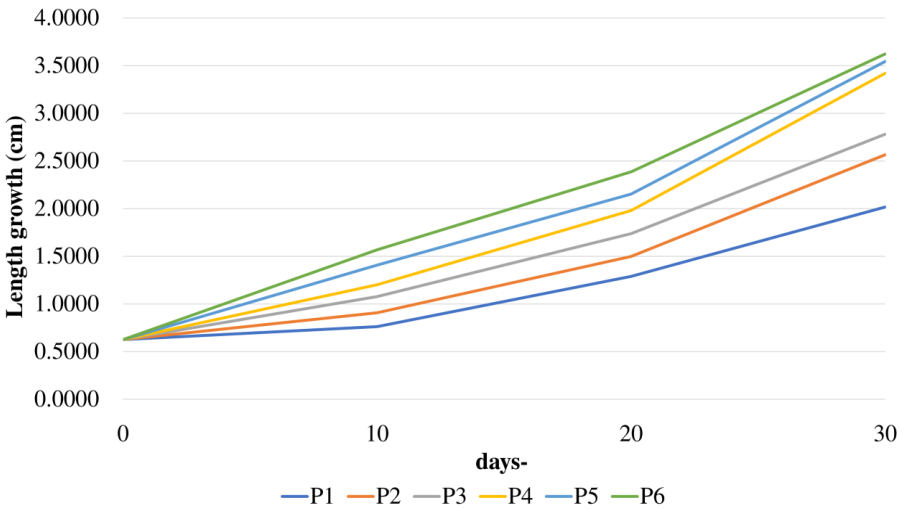

Figure 2. Length growth pattern of Asian redtail catfish postlarvae per 10 days.

and increase in feed nutritional value through fermentation. In addition to increasing the nutrient content of feed and decreasing the concentration of antinutrients (Sharawy *et al.,* 2016; Dawood & Koshio, 2020), fermentation can also enhance the preferential behavior of fish towards particular foods (Zhuo *et al.,* 2021; Heltonika *et al.,* 2021).

Curcumin plays an essential role, as indicated by the growth performance value of Asian redtail catfish postlarvae (Table 1). The addition of curcumin to the regimen resulted in significant improvements in both weight and length of growth ($P<0.01$). Curcumin has been shown to enhance fish growth (Heltonika *et al.,* 2016; Hasby *et al.,* 2022; Heltonika, 2022) by bolstering the immune system (Xia *et al.,* 2015; Akdemir *et al.,* 2016). This is attributed to curcumin's antioxidant properties, as documented by Manju *et al.* (2012) and Setyowati and Suryani (2013).

Antioxidants are essential for the functions of the body that mitigate the damage caused by free radicals. Another mechanism by which curcumin facilitates growth is by enhancing the function of the liver and biliary system. Curcumin has been shown to improve and boost liver function (Dewi *et al.,* 2018), as well as secrete bile into the small intestine by activating the gallbladder wall, resulting in increased and effective digestion of fats, proteins, and carbohydrates (Pujianti *et al.,* 2013; Nova *et al.,* 2015). Curcumin has a strong ability to bind to estrogen receptor β (Kim & Park, 2012; Lecomte *et al.,* 2017) and raising the activity of the estradiol receptor β has a good effect on growth (Lecomte *et al.,* 2017).

The effect of curcumin to promoting growth related to the improvement of digestive enzymes activities (Jiang *et al.,* 2016) and immunity (Ming *et al.,* 2020; Li *et al.,* 2022). Curcumin enhances muscle function and possesses anti-inflammatory properties (Nanavati *et al.,* 2022), so this causes the fish become healthier and more resilient. Hafez *et al.* (2022) revealed that administration of curcumin increased growth under stressful conditions. Additionally, providing curcumin in optimal amounts can help reduce the activity of pathogenic bacteria in the intestines (Ashry *et al.,* 2021). Certainly, the proper dosage of curcumin is an important factor that must be considered (Nanavati *et al.,* 2022; Eissa *et al.,* 2024).

Based on the results of measuring the survival of Asian redtail catfish postlarvae (Figure 3), P6 (silkworms) is still the best in providing survival, followed by P5 (Commercial fermented feed paste enriched with curcumin 1.05 g/kg feed). Furthermore, the lowest survival was obtained in treatment P1 (Commercial non-feed paste fermentation) ($P<0.01$). Based on survival data, it can be seen that fermented feed does not have a significant influence on survival with non-fermented commercial feed. This can be seen from the survival values in treatments P1 and P2. However, the administration of curcumin had a positive impact on increasing the post-larval survival value of Asian redtail catfish. This can be seen from treatments P3 to P4 ($P<0.01$).

Based on the survival rate, it appears that feeding fermented paste has no effect on the survival rate of Asian redtail catfish postlarvae.

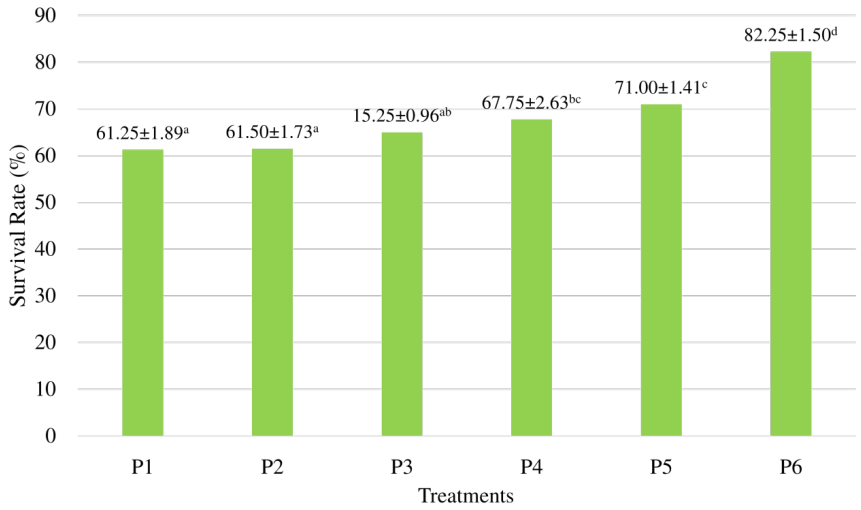

Figure 3. Survival Rate of Asian redtail catfish postlarvae. Different superscripts in value of the graphic bars indicate significant differences ($P<0.01$).

Curcumin, on the other hand, had a significant effect on survival rate (P<0.01). Providing turmeric flour containing curcumin can improve fish survival (Muchdar & Juharni, 2016; Al-faragi & Hassan, 2017; Heltonika, 2022; Siagian & Heltonika, 2023). Based on observations made, many deaths of postlarvae of Asian redtail catfish were found due to cannibalism. Based on several studies, it is stated that Asian redtail catfish have cannibalistic behavior (Heltonika *et al.,* 2017; Heltonika *et al.,* 2021; Heltonika, 2022; Heltonika *et al.,* 2022a; Heltonika *et al.,* 2022b; Heltonika *et al.,* 2022c; Heltonika *et al.,* 2023a; Heltonika *et al.,* 2023b).

The water quality in the rearing medium throughout the study remained within the acceptable limits for Asian redtail catfish. The temperature range was 26.8 to 29.3°C, the pH range was 5.7 to 6.6 ppm, and the DO range was from 5.2 to 7.5 ppm, as indicated in Table 5. In contrast to the rearing conditions observed for Asian redtail catfish postlarvae (Heltonika *et al.,* 2022b), these conditions exhibited minimal variation, ranging from 27 to 29 degrees Celsius, pH to 6.5, and DO to 7.5 parts per million. As stated by Yudha *et al.* (2018), the water quality parameters that are suitable for the cultivation of Asian redtail catfish encompass a range of 27-30°C temperature, 5.0-7.0 pH, and 5.0-7.0 ppm dissolved oxygen.

CONCLUSION

The growth evaluation results indicate that substituting silkworm feed with fermented feed supplemented with curcumin at a concentration of 1.05 g/kg resulted in growth of 6.66% (length) and 14.29% (weight) lower than the silkworm treatment. Despite this decline, it represents the most effective outcome in this study, highlighting the potential of fermented feed where enrichment with curcumin is an alternative to silkworms for Asian redtail catfish larvae nutrition. In conclusion, curcumin-enriched fermented feed can promote the growth of Asian redtail catfish postlarvae. Then, the application of curcumin on fermented feed effectively enhanced the survival value of the Asian redtail catfish. Further research is required to determine the optimal level of curcumin enrichment in commercial fermented paste feed for Asian redtail catfish postlarvae. Based on the findings of this study, the higher enrichment fed with curcumin (1.05 g/kg fed) is the best performance to be alternative fed to change silkworm.

ACKNOWLEDGMENTS

Thank you to the Chancellor of the University of Riau and the Institute for Research and Community Service of University of Riau, have funded this research through DIPA funds at the University of Riau with a research scheme in the field of science with contract number Contract Number: 8217/UN19.5.1.3/AL.04/2023

REFERENCES

Akbarurrasyid M, Kristiana I, Astiyani WP, Efendi D. 2021. Pengaruh pemberian probiotik pelepah pisang (*Musa paradisiaca*) pada pakan komersial terhadap pertumbuhan dan kelangsungan hidup ikan nila (*Oreochromis niloticus*). Marine and Fisheries Science Technology Journal 2: 99–106. (In Indonesian).

Akdemir F, Orhan C, Tuzcu M, Sahin N, Juturu V, Sahin K. 2016. The efficacy of dietary curcumin on growth performance, lipid peroxidation and hepatic transcription factors in rainbow trout *Oncorhynchus Mykiss* (Walbaum) reared under different stocking densities. Aquaculture research 47: 1–10.

Al-Faragi JK, Hassan MAH. 2017. Efficiency of dietary turmeric on growth performance, hematology and survival rate in common carp (*Cyprinus carpio*) challenged with *Flexibacter*

Table 5. Water quality at Asian redtail catfish postlarvae rearing.

Treatment	Temperature (°C)	pH	Dissolved Oxygen (ppm)
P1	26.8–29.3	5.7-6.3	5.3-6.7
P2	27.2–29.0	5.8-6.5	5.4-6.5
P3	27.0–29.1	5.7-6.6	5.3-6.5
P4	26.8–29.0	5.6-6.3	5.8-6.6
P5	27.3–29.3	5.7-6.2	5.4-6.4
P6	26.9–29.2	5.8-6.5	5.3-6.2

columnaris. Kufa Journal for Veterinary Medical Sciences 8: 130–140.

Aliyu-A A, Aliyu-Paiko M, Abafi J, Abdul-Mailk AQ, Adamu K, King M. 2019. Fermentation of feed ingredients as potential strategy to improve health status and reduce opportunistic pathogens in fish farming. Asian Journal of Biotechnology and Bioresource Technology 5: 1–17.

Anis MY, Hariani D. 2019. Pemberian EM4 (effective microorganisme 4) hasil kultur dalam media yang berbeda pada pakan untuk budi daya lele (*Clarias* sp.). Jurnal Riset Biologi dan Aplikasinya 1: 1–8. (In Indonesian).

Ashry AM, Hassan AM, Habiba MM, El-Zayat A, El-Sharnouby ME, Sewilam H, Dawood MAO. 2021. The impact of dietary curcumin on the growth performance, intestinal antibacterial capacity, and haemato-biochemical parameters of gilthead seabream (*Sparus aurata*). Animals 11: 1779.

Cahyanurani AB, Ramadhani I, Suprihadi, Widodo A, Arifin MZ. 2023. Study of semi natural breeding of baung fish (*Hemibagrus Nemurus*). Journal Perikanan 13: 51–61.

Danu R, Adelina, Heltonika B. 2016. Pemanfaatan fermentasi daun singkong (*Manihot utilisima* Pohl.) dalam pakan buatan terhadap pertumbuhan dan kelulushidupan benih ikan gurami (*Osphronemus gouramy* Lac.). Jurnal Online Mahasiswa Faperika 3: 1–12. (In Indonesian).

Dawood MAO, Koshio S. 2020. Application of fermentation strategy in aquafeed for sustainable aquaculture. Reviews in aquaculture 12: 987–1002.

Dewi CD, Manalu W, Ekastuti DR, Sudrajat AO. 2018. The role of turmeric powder supplementation in improving liver performances to support the production of siam catfish (*Pangasianodon hypophthalmus*). Omni-Akuatika 14: 44–53.

Eissa ESH, Awlya OF, Abusudah WF, Qadhi AH, El-Aziz YMA, Rinthong P, Abdelnour SA, Munir MB, Eissa MEH, Sakr SE. 2024. Curcumin's effects on growth indices, histological scores, blood metabolites, redox state, immunity, and antioxidant-related genes of red tilapia (*Oreochromis* sp.). Aquaculture International 32: 7031–7046.

Hafez MH, El-Kazaz SE, Alharthi B, Ghamry HI, Alshehri MA, Sayed S, Shukry M, El-Sayed YS. 2022. The impact of curcumin on growth performance, growth-related gene expression, oxidative stress, and immunological biomarkers in broiler chickens at different stocking densities. Animals 12: 958.

Hasby M, Johan TI, Antoni A. 2022. Pengaruh pemanfaatan hasil limbah cair tahu fermentasi terhadap kelulushidupan dan pertumbuhan ikan puyu (*Hemibagrus Nemurus*). Dinamika Pertanian 38: 127–136. (In Indonesian).

Heltonika B, Sukendi, Hartati R. 2016. Pengaruh penambahan kurkuma pada tubifex sp terhadap pertumbuhan larva ikan betok (*Anabas testudinius*). Berkala Perikanan Terubuk 44: 33–39. (In Indonesian).

Heltonika B, Karsih OR. 2017. Pemeliharaan benih ikan baung (*Hemibagrus Nemurus*) dengan teknologi photoperiod. Berkala Perikanan Terubuk 45: 125–137. (In Indonesian).

Heltonika B, Zairin MJ, Widanarni, Suprayudi MA, Manalu W, Hadiroseyani Y. 2021. Green catfish (*Hemibagrus nemurus*) seeds cannibali at different stocking densities. IOP Conference Series: Earth and Environmental Sciences 695: 1–5.

Heltonika B. 2022. Study of Studi Pengendalian Hormonal Terhadap Kanibalisme Pada Ikan Baung (*Hemibagrus nemurus*) [Thesis]. Bogor (ID): IPB University.

Heltonika B, Afriani S, Siagian DR, Lesmana I, Karsih OR. 2022a. Potential of fermented commercial feed to replace silk worms on post larvae of Asian Redtail catfish (*Hemibagrus nemurus*). IOP Conference Series: Earth and Environmental Science, 1118: 012002.

Heltonika B, Sudrajat AO, Zairin MJ, Widanarni, Suprayudi MA, Manalu W, Hadiroseyani Y. 2022b. Cannibalistic behavior and way of predation among the fry of Asian redtail catfish *Hemibagrus nemurus* at different stocking densities. AACL Bioflux 15: 1154–1161.

Heltonika B, Sudrajat AO, Zairin MJ, Widanarni, Suprayudi MA, Manalu W, Hadiroseyani Y. 2022c. The effect of dietary supplemental tryptophan on cannibalism and steroid hormones concentration of Asian redtail catfish (*Hemibagrus nemurus*) juveniles. Jurnal Riset Akuakultur 17: 133–144.

Heltonika B, Sudrajat AO, Zairin MJ, Widanarni, Suprayudi MA, Manalu W, Hadiroseyani Y. 2023a. Immersion effect of estradiol-17β on cannibalism of Asian redtail catfish (*Hemibagrus nemurus*) post larvae. Jurnal Ilmiah Perikanan dan Kelautan 15: 95–105.

Heltonika B, Sudrajat AO, Zairin MJ, Widanarni, Suprayudi MA, Manalu W, Hadiroseyani Y.

2023b. Cannibalism performance of Asian redtail catfish (*Hemibagrus nemurus*) fed ration supplemented with different doses of 17α-Methyltestosterone. Indonesian Aquaculture Journal 18: 27–35.

Heltonika B, Aryani N, Safitri AR, Mukti PIT, Nuraini, Lesmana I. 2023c. Potensi Pakan Pasta Dari Pakan Komersial yang Difermentasi Pada Ikan. Pontianak, Indonesia: Taman Karya.

Herawati VE, Nugroho RA, Hutabarat J, Karnaradjasa O. 2016. Profile of amino acids, fatty acids, proximate composition and growth performance of *Tubifex tubifex* culture with different animal wastes and probiotic bacteria. AACL Bioflux 9: 614–622.

Jiang J, Wu XY, Zhou XO, Feng L, Liu Y, Jiang WD, Wu P, Zhao Y. 2016. Effects of dietary curcumin supplementation on growth performance, intestinal digestive enzyme activities and antioxidant capacity of crucian carp *Carassius auratus*. Aquaculture 463: 174–180.

Kim SH, Park MJ. 2012. Effects of phytoestrogen on sexual development. Korean Journal Pediatric 55: 265–71.

Kinayungan PP, Helmiati S. 2021. Effect of substitution of soy meal with fermented lemna flour on the growth of red tilapia (*Oreochromis* sp.). Journal of Fish Nutrition 1: 136–145.

Laheng S, Fiansi, Ambarwati. 2020. Efek pemuasaan dan pakan fermentasi terhadap laju pertumbuhan dan feed convertion ratio ikan nila (*Oreochromis niloticus*). Jurnal Akuakultur Rawa Indonesia 8: 102–110. (In Indonesian).

Lecomte S, Demay F, Ferriere F, Pakdel F. 2012. Phytochemical targeting estrogen receptors: beneficial rather than adverse effects?. International Journal Molecular Science 16: 1–9.

Li M, Kong Y, Wu X, Guo G, Sun L, Lai Y, Zhang J, Niu X, Wang G. 2022. Effects of dietary curcumin on growth performance, lipopolysaccharide-induced immune responses, oxidative stress and cell apoptosis in snakehead fish *Channa argus*. Aquaculture Reports 22: 100981.

Maicas S. 2020. The role of yeasts in fermentation processes. Microorganisms 8: 1142.

Manju M, Akbarsha MA, Oommen OV. 2012. In vivo protective effect of dietary curcumin in fish *Anabas testudines* (Bloch). Fish Physiology and Biochemistry 38: 309–318.

Ming J, Ye J, Zhang Y, Xu Q, Yang X, Shao X, Qiang J, Xu P. 2020. Optimal dietary curcumin improved growth performance, and modulated innate immunity, antioxidant capacity and related genes expression of NF-κB and Nrf2 signaling pathways in grass carp (*Ctenopharyngodon idella*) after infection with *Aeromonas hydrophila*. Fish & Shellfish Immunology 97: 540–553.

Muchdar F, Juharni. 2016. Penambahan ekstrak kunyit (*Curcuma domestica*) terhadap pertumbuhan benih ikan nila (*Oreochromis niloticus*). Prosiding Seminar Nasional Kemaritiman dan Sumberdaya Pulau-Pulau Kecil 1: 20–26. (In Indonesian).

Mudlofdar F, Hutagalung RA, Salim R. 2021. The effect of differences of live feed on the growth and survival of redtail catfish (*Hemibagrus Nemurus*) Larvae. Journal of Aquaculture Science 6: 48–57.

Nanavati K, Rutherfurd-Markwick K, Lee SJ, Bishop NC, Ali A. 2022. Effect of curcumin supplementation on exercise-induced muscle damage: a narrative review. European journal of nutrition 61: 3835–3855.

Nova TD, Sabrina, Trianawati. 2015. The effect of various amount of turmeric powder (*Curcuma domestica* Val) in ration toward the carcass of local (Pitalah –West Sumatra) Duck. Jurnal Peternakan Indonesia 17: 200–209.

Pujianti NA, Jaelani A, Widaningsih N. 2013. Penambahan tepung kunyit (*Curcuma domestica*) dalam ransum terhadap daya cerna protein dan bahan kering pada ayam pedaging. Jurnal Ilmu Pertanian 36: 49–59.

Setyowati A, Suryani CL. 2013. The increase of curcuminoida content and antioxidative activity of temulawak and turmeric instans baverages. Agritechnoogy 33: 363–370.

Sharawy Z, Goda AMAS, Hassaan MS. 2016. Partial or total replacement of fish meal by solid state fermented soybean meal with *Saccharomyces cerevisiae* in diets for Indian prawn shrimp, *Fenneropenaeus indicus*, Postlarvae. Animal Feed Science and Technology 212: 90–99.

Sharma R, Garg P, Kumar P, Bhatia SK, Kulshrestha S. 2020. Microbial fermentation and its role in quality improvement of fermented foods. Fermentation 6: 106.

Siagian DR, Aryani N, Heltonika B, Tartila SSQ. 2022. Evaluation of feeding periods of combination between tubificid worms

and formulated feed paste on growth and survival of giant gourami larvae. Jurnal Riset Akuakultur 17: 265–277.

Siagian DR, Heltonika B. 2023. Supplementation of turmeric flour on survival of Asian redtail catfish (*Hemibagrus nemurus*). Jurnal Natur Indonesia 21: 47–54.

Sukmawati D, Sukendi, Aryani N. 2022. Effect of light in the container and dosage of *Tubifex* sp. on the growth and survival of Asian Redtail catfish (*Hemibagrus nemurus*) larvae. Journal Tropical Fisheries 17: 10–18.

Syafitra A, Agusnimar, Rosyadi. 2018. Effect of differences increasing percentage of salt work according to agelarva on life continuation growth of larva fish (*Hemibagrus nemurus*). Jurnal Dinamika Pertanian XXXIV: 69–74.

Telaumbanua BV, Telaumbanua PH, Lase NK, Dawolo J. 2023. Penggunaan probiotik em4 pada media budidaya ikan: review. TRITON: Jurnal Manajemen Sumberdaya Perairan 19: 36–42.

Xia SL, Ge XP, Liu B, Xie J, Miao LH, Ren MC, Zhou QL, Zhang WX, Jiang XJ, Chen RL, Pan LK. 2015. Effects of supplemented dietary curcumin on growth and non-specific immune responses in juvenile wuchang bream (*Megalobrama amblycephala*). The Israel Journal of Aquaculture 67: 1–12.

Yudha RA, Putri B, Diantari R. 2018. Kesesuaian perairan untuk budidaya ikan baung (*Mystus nemurus*) di Sungai Way Kiri Desa Panaragan Kabupaten Tulang Bawang Barat . Jurnal Sains Teknologi Akuakultur 2: 48–57.

Zhuo LC, Jazlyn DN, Yong ASK, Shapawi R, Lin YH. 2021. Effects of fermented lemon peel supplementation in diet on growth, immune responses, and intestinal morphology of Asian sea bass, *Lates calcarifer*. Aquaculture Reports 21: 100801.