Asian Journal of Aquatic Sciences, December 2025. Vol 8, Issue (3) 356-363
e-issn: 2716-4608
p-issn: 2655-366X

EFFECTIVENESS OF REPLACING *Artemia* sp. FEED WITH FERMENTED PASTE FEED ON THE GROWTH AND SURVIVAL OF STRIPED CATFISH LARVAE (*Pangasionodon hypopthalmus*) PUSTINA STRAIN

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ABSTRACT

Striped catfish (*Pangasianodon hypophthalmus*) in Riau is known as a commodity with bright prospects for cultivation, given increasing market demand aligned with community needs and its affordable price. This study was conducted from April 28 to June 7, 2025, at the Fish Breeding and Improvement Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau. The objective of this study was to determine the optimal timing for switching from *Artemia* sp. feed to fermented paste feed to enhance the growth and survival rate of Pustina strain striped catfish larvae. The method used was an experimental method with five treatments and three replicates (15 experimental units) with a stocking density of 75 fish/tank and with treatments AR 5 T 5 PBF 30 (*Artemia* sp. 5 days + silkworms 5 days + Fermented Paste Feed 30 days), AR 5 T 7 PBF 28 (*Artemia* sp. 5 days + silkworms 7 days + Fermented Paste Feed 28 days), AR 5 T 9 PBF 26 (*Artemia* sp. 5 days + silkworms 9 days + Fermented Paste Feed 26 days), AR 5 T 11 PBF 24 (*Artemia* sp. 5 days + silkworms 11 days + Fermented Paste Feed 24 days), AR 5 T 13 PBF 22 (*Artemia* sp. 5 days + silkworms 13 days + Fermented Paste Feed 22 days). The best treatment was AR 5 T 13 PBF 22 (*Artemia* sp. 5 days + silkworms 13 days + Fermented Paste Feed 22 days), which produced absolute weight growth of 2.49 ± 0.037^{e}, absolute length growth of 5.99 ± 0.62^{e}, specific growth rate of 17.16 ± 0.05^{e}, and survival rate of 87.11 ± 2.03^{a}.

Keywords: Striped Catfish, Fermented, Growth, Pustina

1. INTRODUCTION

Striped catfish (*Pangasianodon hypophthalmus*) in Riau is known as a commodity with bright prospects for cultivation, given increasing market demand aligned with community needs and its affordable price[1]. In 2009, the Freshwater Aquaculture Center (BPBAT) in Sungai Gelam, Jambi, produced an innovation related to the Pustina strain of striped catfish, the result of selective breeding of patin broodstock. Some advantages of the new Pustina strain of catfish include its large size (3.0 kg/fish), strong potential for cultivation, fast growth rate, omnivorous nature, and tolerance of unfavorable water conditions[2].

Striped catfish larvae aged 0-15 days are in a critical phase due to incomplete development of their eyes and bodies, resulting in a 41% mortality rate. The cannibalistic nature of catfish is particularly evident when the food reserves, in the form of egg yolk, are absorbed during the transition period from the endogenous to exogenous feeding phase[3]. *Artemia* sp. is the initial feed given to catfish larvae after the egg yolk has been absorbed. Then, *Tubifex* sp. is a live feed usually given to catfish larvae after *Artemia* sp. nauplii are

Received: 25 October 2025
Accepted: 12 December 2025

administered[4]. However, in its application, Artemia sp. has a weakness: its short freshwater maintenance duration, around 5 hours[5].

Furthermore, the availability of Tubifex sp. is currently limited because it is still caught naturally and is not available year-round[6]. Therefore, in catfish hatchery activities, an alternative to *Artemia* sp. feed is needed, namely, silkworms fed fermented commercial feed. However, the optimal time to administer artificial feed needs to be evaluated based on the development of the catfish larvae's digestive system, which is still imperfect.

Replacing live feed with artificial feed in hatchery activities can reduce production costs[7,8]. Adequately controlled feeding of natural feed can reduce the risk of cannibalism and increase profits in hatchery operations. Commercial feed that has the potential to replace *Artemia* sp. is PF0 feed fermented with EM4 to form a paste.

Research using EM_4 fermenters at a dose of 20 ml/kg of feed has resulted in absolute weight growth of 0.23 g, absolute length of 1.23 cm, specific growth rate of 8.85%/day, and survival rate of 84.44% in gurami[9]. Furthermore, research on replacing natural silkworm feed with paste feed in gurami larvae resulted in absolute length growth of 2.18 cm and weight of 0.45 g[10]. Then, Utami's[11] research on replacing *Tubifex* sp. feed with artificial feed in gabus fish larvae resulted in a weight growth of 1.73 g, a length of 3.84 cm, and a survival rate of 88.89%.

Based on the background described, replacing *Artemia* sp. feed with fermented paste feed has the potential to increase the growth and survival rates of striped catfish larvae of the Pustina strain. Furthermore, replacing natural feed with commercial feed can compensate for feed shortages and reduce production costs.

2. RESEARCH METHOD

Time and Place

This research was conducted in May-June 2025 during a 40-day maintenance period at the Fish Breeding and Improvement Laboratory (PPI) of the Faculty of Fisheries and Marine Sciences, Universitas Riau.

Method

The treatment applied in this study was based on Suprayudi et al.[12]. Feeding artificial feed to *Pangasionodon* sp. catfish larvae at different ages resulted in the highest total length growth of 1.66 cm and the highest survival rate of 76% with feeding *Artemia* sp. for 3 days, silkworms for 6 days, and artificial feed for 6 days. The design used was a Completely Randomized Design (CRD) with five treatments and three replicates. The treatments used in this study were:

P1 = *Artemia* sp. 5 days (AR) → silkworms 5 days (CS) → fermented paste feed 30 days (PPT)

P2 = *Artemia* sp. 5 day (AR) → silkworms. 7 days (CS) → fermented pasta feed 28 days (PPT)

P3 = *Artemia* sp. 5 days (AR) → silkworms 9 days (CS) → fermented pasta feed 26 days (PPT)

P4 = *Artemia* sp. 5 days (AR) → silkworms 11 days (CS) → fermented pasta feed 24 days (PPT)

P5 = *Artemia* sp. 5 day (AR) → silkworms 13 days (CS) → fermented pasta feed 22 days (PPT)

Procedures

The test fish used were 450 two-day-old post-larvae of the Pustina strain of catfish. These fish were obtained from Mr. Haris' hatchery. The feed used in this study was *Artemia* sp. with the trademark Supreme Plus produced by GSL USA, followed by commercial PF-0 feed in paste form, which was then fermented with a fermenter dose of 20 ml/kg of feed until the end of the study. The fermentation process required EM4, sweetened condensed milk, and mineral water in a 1:1:10 ratio[9].

The containers used in this study were 15 aquariums measuring 30 x 30 x 30 cm, located in the Fish Breeding and Breeding Laboratory at the Faculty of Fisheries and Marine Sciences, Universitas Riau, and equipped with aeration systems. The water used was obtained from a borehole at the Fish Breeding and Breeding Laboratory, which had been settled in a reservoir for 3 days.

3. RESULT AND DISCUSSION

The results of observations of the response of pustina strain catfish larvae to the effectiveness of replacing *Artemia* sp. feed with fermented paste feed during 40 days of maintenance are presented in Table 1.

Table 1. Larval response to feed

Treatment	Fermented Pasta Feed			
	How Larvae Obtain Food	Larvae Attraction to Feed	Feed Residue	Total
P1	3	3	3	9
P2	3	3	3	9
P3	5	5	5	15
P4	5	5	5	15
P5	5	5	5	15

Description: Score 1, larvae are not aggressive in feeding, larvae swim slowly to feed, and there is a lot of leftover food at the bottom of the container. Score 3: Larvae are aggressive in taking food; they swim quickly to it, leaving little food at the bottom of the container. Score 5: Larvae are very aggressive in taking food, larvae swim very quickly to take food, and no food remains

Based on Table 1, the results of observations on the response of pustina strain catfish larvae to feed show that the feed given affects the response of the fish larvae. In treatments P1 and P2, the response value was 9, indicating that the larvae were less aggressive in feeding. This is thought to be because, in treatments P1 (12-day-old larvae) and P2 (14-day-old larvae), the larvae were not yet fully able to accept the fermented feed, likely because their digestive organs were not fully developed. This aligns with Andriani's[13] view that during this phase, the larvae are still undergoing organ formation. This is supported by the findings of Indriastuti et al.[14], who note that when larvae are between 2 and 14 days old, digestive enzyme activity in striped catfish larvae remains fluctuating.

In treatments P3 and P4, the responses were a total score of 15, with the same score but different growth rates. This was because in treatment P3, the larvae were 16 days old, whereas in treatment P4, they were 18 days old and able to accept the fermented paste feed. The silkworms provided a distinctive aroma that was high in nutrients to stimulate growth[15]. This was also associated with the larvae's readiness to accept the paste feed, which greatly influenced the growth of patin fish larvae. In line with the findings of Indriastuti et al.[14], enzyme activity in catfish larvae is stable at 14 days old, and they can utilize fermented feed.

In treatment P5, the response had a total score of 15, where the larvae were very aggressive in taking feed. This is thought to be because, at 20 days old, P5 was very ready to accept fermented-paste feed, as their digestive organs were fully formed. The larvae's response to fermented-paste feed was very aggressive, as evidenced by the absence of feed residue each time it was given to the patin fish larvae. This is supported by the statement of Indriastuti et al.[14] that enzyme activity stabilizes at 14 days of age and can be supplemented with artificial feed. This aligns with Mukti et al.[16], who found that fermented feed has a soft structure, making it easy for fish larvae to digest, and provides good nutritional content for growth.

Proximate Analysis

The results of the proximate analysis of fermented feed with a dose of 20 ml/kg EM4 and non-fermented feed are listed in Table 2.

Table 2. Proximate analysis of feed paste before and after fermentation

Composition	Percentage (%)	
	Before Fermentation	After Fermentation
Protein	34,57	40,56
Fat	3,15	5,31
BETN	0,87	0,71
Coarse Fiber	1,02	0,86
Ash	6,59	6,35
Water Content	53,80	46,21

Source: Lase et al.[9]

The results of the study on the effectiveness of replacing *Artemia* sp. feed with fermented paste feed on the absolute weight growth (g), absolute length growth (cm), and specific growth rate (%) of pustina strain striped catfish larvae raised for 40 days are listed in Table 3.

The increase in absolute weight gain is thought to be due to the nutritional content of *Naupli Artemia* sp., which is 56.84% protein, 17.83% fat, 1.70% BETN, and 12.04% ash[17]. Furthermore, *Artemia* sp., which is very small (under 500 µm), is suitable for the mouth opening size of 3-day-old larvae, which is 145-150 mm8,18. This aligns with Hossain et al.[19], who state that natural feed contains all nutrients, including protein, lipids, carbohydrates, vitamins, minerals, amino acids, and fatty acids, which are beneficial for growth. The average weight gain in P5 was higher, at 2.49 g. The highest average weight was found in the P5 treatment because the feed given was silkworms for 13 days longer than the other treatments.

Table 3. Absolute weight growth (g), absolute length growth (cm), specific growth rate (%), and survival rate (%) of striped catfish larvae pustina strain

Treatment	Absolute Weight Gain (g)	Absolute Length Growth (cm)	Specific Growth Rate (%)
P1	2,06 ± 0,037^{a}	5,16 ± 0,20^{a}	16,69 ± 0,04^{a}
P2	2,14 ± 0,046^{b}	5,56 ± 0,20^{b}	16,78 ± 0,05^{b}
P3	2,22 ± 0,028^{c}	6,00 ± 0,20^{c}	16,88 ± 0,03^{c}
P4	2,32 ± 0,027^{d}	6,43 ± 0,20^{d}	16,99 ± 0,02^{d}
P5	2,49 ± 0,051^{e}	6,80 ± 0,10^{e}	17,16 ± 0,05^{e}

Description: P1: *Artemia* sp. 5 days + silkworms 5 days + Fermented Paste Feed 30 days, P2: *Artemia* sp. 5 days + silkworms 7 days + Fermented Paste Feed 28 days, P3: *Artemia* sp. 5 days + silkworms 9 days + Fermented Paste Feed 26 days, P4: *Artemia* sp. 5 days + silkworms 11 days + Fermented Paste Feed 24 days, P5: *Artemia* sp. 5 days + silkworms 13 days + Fermented Paste Feed 22 days. Different superscript letters in the same column indicate significant differences ($P<0.05$).

The high average weight observed in the P5 treatment on days 10 to 20 was also due to the high protein content in silkworms, which is consistent with Siagian et al.[10], who reported that the longer silkworms are fed, the greater the absolute weight produced. Growth in treatment P5 also increased, presumably because the content of silkworms was also higher than other feeds, namely protein (77.42%), fat (14.15%), BETN (0.44%), and amino acids, and contained enzymes that aid the digestive process so that the larvae can digest the feed optimally[17]. Furthermore, the exogenous enzymes contained in silkworms can influence the development of the digestive glands, namely the pancreas, to produce digestive enzymes in the fish's body[20].

Based on the research results, on the 20th day of treatment (P5 AR 5 days + CS 13 days), it is the right time to replace natural feed with fermented paste feed. This is because the feed being replaced, namely fermented paste feed, is suitable for developing the larvae's digestive tract, which already contains digestive enzymes similar to those of adult fish, enabling the larvae to utilize the feed they consume optimally. The lowest average weight was found in treatment P1 because the natural feed (AR 5 days + CS 5 days) given to the test larvae was very short, only 10 days. Then the larvae needed time to adapt to the fermented feed so that the results could be used for growth.

In addition, in treatment P1, the larvae were still 12 days old, which is in accordance with what was stated by Indriastuti et al.[14] that enzyme activity still fluctuates until the age of 14 days, so that when fermented paste feed is given, the larvae do not fully respond and utilize the feed provided, resulting in slow growth. Digestive enzyme activity is a good indicator of digestive capacity. When digestive enzyme activity is high, it indicates that the larvae are physiologically ready to process external feed.

The high average growth rate increases with the replacement of silkworm feed with fermented paste feed. Therefore, the longer the larvae receive natural feed, the better it is for increasing growth and digestive enzyme activity. Based on these results, it can be concluded that the optimal time to administer fermented paste feed is on the 20th day after the initial administration of natural feed (*Artemia* sp. and silkworms). Additionally, the fermentation process alters the feed structure, making it softer and finer, and changes its aroma to a slightly acidic scent, which attracts the larvae[21].

In line with the absolute weight growth in treatment P5, which was 42 days old, it remained the treatment with the highest length growth, due to the long period of *Tubifex* sp. feed use of up to 13 days. At this stage, the larvae were ready to receive fermented paste feed. Then, the average length of development began to show significant differences because at this phase, the test larvae were able to accept and utilize fermented artificial feed for length growth. The lowest average length was observed in P1 because the timing of artificial feeding was not yet appropriate, as the larvae were still in the organ development stage. This was also consistent with enzyme activity, which still fluctuated from day 2 to day 14, and the larvae could not fully utilize the fermented artificial feed for growth in length and average weight.

Based on this, it is expected that the addition of EM-4 fermenters will enable the secretion of exogenous enzymes such as cellulase, lipase, and amylase. Exogenous enzymes will degrade complex nutrients in feed into simpler nutrients, although the process is not yet perfect. The feed fermentation process will then be perfected in the fish's digestive tract with the help of endogenous enzymes in both the stomach and small intestine, stomach acid, and exogenous enzymes from the fermenter that remain in the feed. The feed consumed will be easier to digest and more quickly absorbed by the small intestine.

The ability of fish larvae to digest the provided feed increases with age and size, but if the feed is unsuitable and the larvae do not respond, they will not be able to utilize it optimally, and growth will be stunted[22]. The faster the switch from *Artemia* sp. to silkworms, the faster the average weight gain. Switching to fermented artificial feed can reduce feed costs, but it must be given at the right time during the feed transition, as improper timing will disrupt the growth of fish larvae.

The highest specific growth rate was found in treatment P5 at 17.16%/day, resulting in good weight and length growth. This was due to the combination of natural and artificial feed being replaced as the digestive tract of pustina strain patin fish larvae developed. The lowest specific growth rate was obtained in treatment P1 at 16.69%/day. Providing artificial feed at the beginning of the rearing period was expected to accelerate digestive enzyme activity. However, the feed provided was not in accordance with the development of the digestive organs of the psutina strain catfish larvae, thereby inhibiting their weight and length growth.

Survival Rate of Pustina Strain Striped Catfish Larvae

The results of a study on differences in feeding duration for pustina strain catfish larvae raised for 40 days showed that the average survival rate ranged from 81.77 to

87.11%. The average survival rate (SR) for each treatment is presented in Table 4.

The average survival rate of Pustina strain striped catfish larvae in treatment P1 was 84.88%, followed by P2 at 86.66%, P3 at 84.89%, P4 at 84.44%, and P5 at 87.11%. The treatment involving 5 days of *Artemia* sp., 13 days of *Tubifex* sp., and 22 days of PPT yielded the best survival rate because the larvae had already adapted to natural feed for an extended period. Consequently, when transitioning to fermented artificial feed, the larvae readily accepted the feed.

Table 4. Type A cannibalism, Type B cannibalism, cannibalism index, normal mortality, and survival rate of Pustina strain catfish larvae reared for 40 days.

Treatment	KTA	KTB	Cannibalism Index	Natural Death	Survival rate
P1	5.33±2.30ᵃ	8.00±1.33ᵃ	13.00±1.33ᵃ	2.22±2.03ᵃ	84.88±4.07ᵃ
P2	7.11±3.84ᵃ	5.33±2.66ᵃ	12.44±2.03ᵃ	0.89±0.76ᵃ	86.67±2.66ᵃ
P3	7.56±2.03ᵃ	5.33±2.66ᵃ	12.89±0.76ᵃ	2.22±0.77ᵃ	84.89±1.54ᵃ
P4	6.67±2.66ᵃ	7.11±0.76ᵃ	13.78±2.77ᵃ	1.78±1.54ᵃ	84.44±2.77ᵃ
P5	5.78±2.77ᵃ	6.22±0.77ᵃ	12.00±2.30ᵃ	0.89±0.76ᵃ	87.11±2.03ᵃ

Note: Mean values in the same column followed by the same letter indicate no significant difference (P>0.05), while columns followed by different letters indicate significant differences (P<0.05).

Cannibalism is the habit of fish eating other fish of the same species in a population, either whole or in part[23]. Deaths due to cannibalism can account for more than half of total deaths during cultivation. Cannibalism is often intense during the larval and seedling phases. This aligns with Heltonika et al.[21], who state that there are two types of cannibalism index: type A and type B. Type A cannibalism is a condition in which fish die with damage to their bodies, whether it be their tails, stomachs, heads, or parts of their bodies being eaten. Type B cannibalism is a condition where the fish is completely eaten or disappears during the study. From P5 to P1, it was shown that the timing of feed replacement and the suitability of the feed provided can increase the survival rate (SR) of catfish larvae. Cannibalism in baung fish larvae is categorized into several types, namely Type A, Type B, cannibalism index, and normal mortality.

Water Quality

The temperature during the study ranged from 25 to 28˚C. This indicates that the water quality in the rearing tanks remained within a range that supported the growth and survival of the larvae, which was classified as good for the life and growth of patin larvae. This is consistent with the fact that the temperature of the larval rearing medium for the Pustina strain of catfish was 28.6°C, which is still within the normal range for catfish cultivation[24]. This temperature is ideal for the metabolic processes and enzymatic activity of catfish larvae. At optimal temperatures, larvae can develop well without growth impediments or the risk of disease.

Table 5. Water quality during the study

Measured parameters	Water Quality (Day)		
	Beginning	Middle	The end
Temperature (˚C)	25,9 – 26,5	27,2 – 27,8	28,2 – 28,5
pH	6,5 – 6,8	6,5 – 7,1	6,1 – 7
DO (ppm)	5,7 – 6,1	6,2 – 7,1	5,3 – 6,1

The DO range during the study was 5.7–6.1 mg/L. In general, the DO obtained during the study was ideal for the growth of pangasius larvae. This value is above the minimum SNI standard for striped catfish cultivation, which is ≥ 3 mg/L. Sufficient dissolved oxygen levels are essential to ensure that pangasius larvae grow well and avoid stressful conditions. The recorded DO values indicate optimal conditions that support the growth and development of the larvae.

The pH values obtained during the study ranged from 6.1 to 7, which is considered ideal for the growth of fish larvae. However, in the final quality measurement, some results were 6.1. Although the pH was below the optimal range, the larvae adapted without disturbance, but they still needed to be monitored. Regular monitoring and pH adjustment are important for maintaining water chemistry balance and ensuring conditions remain favorable for hatching and larval growth.

4. CONCLUSION

The effectiveness of replacing Naupli *Artemia* sp. + *Tubifex* sp. feed with fermented paste feed had a significant effect (P<0.05) on absolute weight growth, absolute length growth, specific growth rate, and survival rate of Pustina strain striped catfish larvae. The effectiveness of replacing natural feed with the best artificial feed was in treatment P5 (*Artemia* sp. for 5 days + silkworms for 13 days + fermented artificial feed for 22 days), which resulted in absolute weight growth of 2.49±0.037[e], absolute length growth of 5.99±0.62[e], specific growth rate of 17.16±0.05[e], and survival rate of 87.11±2.03[a].

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