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Supplementation of Turmeric Flour on Survival of Asian Redtail Catfish (*Hemibagrus Nemurus*)

Suplementasi Tepung Kunyit terhadap Kelangsungan Hidup Ikan Baung (*Hemibagrus nemurus*)

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ABSTRACT

Asian redtail catfish culture activities are still constrained by the low survival rate in the seeds phase, one of the causes is cannibalism behavior. Several attempts have been made to improve the survival of these fish, and several studies have shown that turmeric powder can increase survival in several species. Based on this, this study aimed to evaluate the addition of turmeric flour with the coating method on the survival rate of Asian redtail catfish (*Hemibagrus nemurus*) seeds. This study used a completely randomized design using four treatments and was repeated three times. The treatment used was the supplemented turmeric flour to commercial feed which had a protein of 40%., the treatments were 0.0 g kg^{-1} (K), 2.5 g kg^{-1} (TK2.5), 5.0 g kg^{-1} (TK5.0), and 7.5 g kg^{-1} feed (TK7.5). The size of the Asian redtail catfish was 2.09±0.17 cm, with a stocking density of 3 L^{-1}, and reared in an aquarium measuring 38x25x22 cm^3. The study was conducted for 30 days and fed at satiation four times a day. The parameters measured were survival, cannibalism (cannibal type, cannibal index, normal death), and growth performance (absolute weight, absolute length, specific weight growth, and specific length growth). The results showed that TK5.0 was able to increase the survival rate and decrease the cannibalism index and normal death rate. Furthermore, the supplemented turmeric flour did not have an impact on the absolute weight, absolute length, specific growth rate, and specific length.

Keywords: Cannibalism, Growth, *Hemibagrus nemurus*, Survival rate, Turmeric flour

ABSTRAK

Kegiatan budidaya ikan baung masih terkendala oleh rendahnya tingkat kelangsungan hidup pada fase benih, salah satu penyebabnya adalah perilaku kanibalisme. Beberapa upaya telah dilakukan untuk meningkatkan kelangsungan hidup ikan ini, dan beberapa penelitian menunjukkan bahwa tepung kunyit dapat meningkatkan kelangsungan hidup pada beberapa spesies. Berdasarkan hal tersebut, penelitian ini bertujuan untuk mengevaluasi penambahan tepung kunyit dengan metode coating terhadap kelangsungan hidup benih ikan baung (*Hemibagrus nemurus*). Penelitian ini menggunakan rancangan acak lengkap dengan empat perlakuan dan diulang sebanyak tiga kali. Perlakuan yang digunakan adalah penambahan tepung kunyit pada pakan komersial yang memiliki kandungan protein 40%, perlakuan 0,0 g kg^{-1} (K), 2,5 g kg^{-1} (TK2.5), 5,0 g kg^{-1} (TK5. 0), dan 7,5 g kg^{-1} pakan (TK7.5). Ikan baung berukuran 2,09±0,17 cm, padat tebar 3 ekor per L, dipelihara dalam akuarium berukuran 38x25x22 cm^3. Penelitian dilakukan selama 30 hari secara *at satiation* sebanyak empat kali sehari. Parameter yang diukur adalah kelangsungan hidup, kanibalisme (jenis kanibal, indeks kanibal, kematian normal), dan kinerja pertumbuhan (bobot absolut, panjang absolut, pertumbuhan bobot spesifik, dan pertumbuhan panjang spesifik). Hasil penelitian menunjukkan bahwa TK5.0 mampu meningkatkan tingkat kelangsungan hidup dan menurunkan indeks kanibalisme dan tingkat kematian normal. Selain itu penambahan tepung kunyit tidak memberikan pengaruh terhadap nilai berat mutlak, panjang mutlak, laju pertumbuhan spesifik dan laju panjang spesifik benih ikan baung, kecuali pada dosis 2,5 g kg^{-1} yang memberikan nilai lebih rendah.

Kata Kunci: Kanibalisme, Pertumbuhan, *Hemibagrus nemurus*, Kelangsungan hidup, Tepung kunyit

INTRODUCTION

Asian redtail catfish (*Hemibagrus nemurus*) is one of the leading fishery commodities that are in demand by the community, especially in the Malay community. People's need for this fish is still high, but for its fulfillment, it is still predominantly derived from natural catches. Asian redtail catfish farming activities in Riau

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have been carried out since 2006, but based on observations, until now there are still very few fish farming activities. One of the obstacles to Asian redtail catfish farming activities is the low production of seeds, which greatly affects the yield of seeds both in quality and quantity.

Asian redtail catfish hatchery efforts require special attention due to the high mortality rate. One of the factors causing the low level of seed survival is the presence of cannibalism (Heltonika & Karsih 2017; Heltonika *et al*. 2021; Heltonika *et al*. 2022). Cannibalism is the activity of killing and consuming part or all of the body of the same species (Sopha *et al*. 2015). The number of occurrences of cannibalism in Asian redtail catfish is quite high in the seed phase. Meanwhile, mortality in Asian redtail catfish larval stadia can reach 80.8% of the total population, one of which is caused by cannibalism (Kusdiarti *et al*. 2020).

The causes of the occurrence of cannibalism can come from individual (endogenous) and environmental (exogenous) factors. Several efforts have been made to reduce cannibalism in fish with an exogenous approach, namely by optimizing salinity (Nazar *et al*. 2019), stocking density regulation (Heltonika *et al*. 2021; Heltonika *et al*. 2022), and regulating the intensity of light (Heltonika & Karsih 2017). An endogenous approach has also been carried out, namely by regulating the hormonal system (Putri 2022) and manipulating feed (Simatupang *et al*. 2017).

Steroid hormones have a big role against cannibalism, that is suppress the behavior of aggressiveness. Feed enrichment with estradiol-17β is known to suppress aggressive behavior to control the incidence of cannibalism in catfish (Putri *et al*. 2020; Siregar *et al*. 2021). Compounds such as natural estradiol that can be used to provide estrogenic impact are phytoestrogen, which can be obtained from plants, one of which is turmeric. The content of active ingredients in turmeric in the form of phytosterols, carotenes, and vitamin E are similar to phytoestrogens, so it can increase the hormone estrogen (estradiol-17β) in the body (Mukai *et al*. 2013). Some studies have shown that giving turmeric flour to feed can improve fish survival. Ranggayoni *et al*. (2021) stated that the addition of turmeric extract of 6 mL kg^{-1} gave a survival value of 90% in the *Osteochillus kappeni*. The administration of a turmeric dose of 1.5 g resulted in the highest survival value in the red tilapia *Oreochromis niloticus* (Muchdar & Juharni 2017). Furthermore, the administration of curcumin, which is one of the components of turmeric, can increase the survival and growth of climbing perch (Heltonika *et al*. 2016), snakehead fry (Li *et al*. 2022), abalone (Zou *et al*. 2022), grass carp (Ming *et al*. 2020), and comet (Jiang *et al*. 2016).

Therefore, based on the large potential of turmeric in increasing fish survival, it is necessary to conduct a study of turmeric flour supplementation to increase survival and its effect on the incidence of cannibalism of Asian redtail catfish seeds.

MATERIALS AND METHOD

Experimental Design

This study used a complete randomized design with 4 treatments and 3 replications. The treatment used is the addition of turmeric flour through a coating method with a dose of 0.0 (K), 2.5 g kg^{-1} (TK2.5), 5.0 g kg^{-1} (TK5.0), and 7.5 g kg^{-1} (TK7.5) in feed for Asian redtail catfish seeds.

Test Feed

The test feed used is commercial feed with a protein content of 40% and added commercial turmeric flour according to the treatment dose. Turmeric flour is mixed in the feed using the coating method. In one kg of feed, turmeric with the appropriate amount of treatment plus egg white and egg yolk and 100 mL of water, stirred until homogeneous using a mixer. The mixture of such ingredients is sprayed onto the feed evenly. The feed is then dried in an oven with a temperature of 60 °C for ±4 hours. After drying, the feed is stored in an airtight container, and then stored in the freezer to maintain the quality of the feed. In the control feed, there is no addition of turmeric flour by the coating method.

Test Fish Rearing

The test fish used is Asian redtail catfish with a size of 2.09±0.15 cm. Fish are kept in aquariums measuring 38x25x22 cm^3 and stocked with a density of 3 L^{-1} fish. The frequency of feeding is 4 times a day, namely at 08.00, 12.00, 16.00, and 20.00 at satiation. Fish maintenance is carried out for 30 days. Water quality measurements such as dissolved oxygen (DO), temperature, and pH content are carried out once every 10 days.

Measured Parameters

Cannibalism observation is the activity of counting numbers and observing dead fish every day. The calculation of the level of cannibalism is carried out based on Obirikorang *et al*. (2014).

$$\text{Cannibal index (\%)} = \frac{\text{(number of dead fish)}}{\text{(number of initial fish}} \text{ x } 100$$

Cannibalistic behavior is identified based on behaviors that characterize cannibalism types I and II. Type I is cannibalism characterized by the behavior of attacking and eating part of the prey's body, while type II cannibalism is the behavior of swallowing all parts of the prey's body (Naumowicz *et al*., 2017). The type of cannibalism is calculated based on the formula of Król & Zakęś (2016).

$$\text{Type I cannibals (\%)} = \frac{\text{(number of dead injured seed)}}{\text{(initial seed count)}} \text{ x } 100$$

$$\text{Type II cannibals (\%)} = \frac{\text{(number of missing seed eaten)}}{\text{(initial seed count)}} \text{ x } 100$$

The percentage of normal death is a calculation of the number of individuals who die normally, not due to cannibalism during the maintenance period. Normal mortality is caused by other factors such as illness, hunger, and the inability of fish to adapt (Król & Zakęś, 2016). Normal mortality is calculated and observed daily using the following formula:

$$\text{Normal death (\%)} = \frac{\text{(number of dead seed)}}{\text{(number of initial seed)}} \text{ x } 100$$

Survival is the number of fish that live for 30 days of rearing. Survival is calculated according to the following formula:

$$\text{Survival (\%)} = \frac{\text{(number of seeds at the end of the study)}}{\text{(number of seeds at the beginning of the study)}} \text{ 100.}$$

The calculations of absolute length growth, absolute weight, specific weight growth (SGR), and specific length growth (SLR) were carried out based on Effendie (1997):

$$\text{Absolute length} = Pt - P0$$

$$\text{Absolute weight} = Wt - W0$$

$$\text{SGR (\%/day)} = \frac{(\text{Ln wt} - \text{LnWo})}{t} \text{ x } 100$$

$$\text{SLR (\%/day)} = \frac{(\text{Ln Lt} - \text{LnLo})}{t} \text{ x } 100$$

Information:

Pt : Average length of fish at the end of the study (mm)
P0 : Average length of fish at the beginning of the study (mm)
Wt : Average weight of fish at the end of the study (g)
W0 : Average weight of fish at the beginning of the study (g)
t : Length of the study (days)

The water quality parameters observed in this study are temperature, pH, and dissolved oxygen. pH measurement is carried out using a pH meter. Temperature measurement is carried out using a thermometer. While the measurement of dissolved oxygen using a DO meter.

RESULT AND DISCUSSION

Survival and Cannibals

Based on the results of the study, showed that there was an effect of turmeric flour supplementation with the coating method on Asian redtail catfish fry feed on an increase in survival by 20% (Table 1). In addition, there was also a decrease in the value of the cannibalism index and normal mortality events when compared to treatment without turmeric flour supplementation.

Table 1. Value of cannibalism type, cannibalism index, normal death, and survival rate

Parameters	Treatments			
	K	TK2.5	TK5.0	TK7.5
Cannibal Type I (%)	23.33±3.06[a]	24.00±4.00[a]	18.00±3.46[a]	19.33±4.16[a]
Cannibal Type II (%)	19.33±2.31[ab]	14.00±2.00[a]	19.33±1.15[ab]	23.33±4.62[b]
Cannibalism Index (%)	42.67±1.15[b]	38.00±3.46[a]	37.33±2.31[a]	42.67±1.15[b]
Normal Death (%)	24.00±3.46[b]	12.67±3.06[a]	9.33±1.15[a]	12.00±2.00[a]
Survival Rate (%)	33.33±3.06[a]	49.33±4.16[bc]	53.33±3.06[c]	45.33±3.06[b]

Note: Different superscript letters in the same column behind the mean ± standard deviation indicate significant differences (P<0.05).

Based on Table 1 shows that there was no difference in the incidence of type I cannibals in all treatments (P>0.05). Meanwhile, type II cannibals have significant differences between treatments (P<0.05), with the highest incidence of cannibals in the TK7.5 treatment of 23.33±4.62 and the lowest in the TK2.5 treatment of 14.00±2.00. Furthermore, the cannibalism index of turmeric supplementation lowered the value of the cannibal index at the optimal dose (P<0.05), the lowest in the TK5.0 treatment by 37.33±2.31 and did not differ markedly from the TK2.5 treatment. For normal deaths, namely deaths without injuries to the body, there was a difference between treatments (P<0.05), the lowest normal deaths in the TK5.0 treatment were 9.33±1.15 and the highest in the control treatment were 24.00±3.46. Survival parameters showed that turmeric flour supplementation could reduce mortality rates by 20%, the highest survival rate in TK5.0 treatment was 53.33±3.06, while the lowest survival rate in treatment without the addition of turmeric flour was 33.33±3.06 (P<0.05).

Cannibalism is divided into two types, namely, type I and type II cannibalism. Type I cannibalism is cannibalism characterized by the behavior of attacking and eating part of the prey's body, while type II cannibalism is the behavior of swallowing all parts of the prey's body (Naumowicz *et al*., 2017). The type of cannibalism that dominates in this study is type II cannibalism. The lowest type II cannibalism was obtained in the TK2.5 treatment of 14.00±2.00, followed by the treatment of TK5.0 and control of 19.33±1.15 and 19.33±2.31, respectively. This reinforces the suspicion that turmeric flour supplementation in feed can suppress aggressive behavior in Asian redtail catfish fry, with phytoestrogen content that has an estrogenic effect on the body. As Putri *et al*. (2020) reported, the administration of estradiol-17β can decrease aggressive behavior in catfish fry. Turmeric is known to contain phytoestrogens, namely isoflavones that can bind to estrogen receptors that function to suppress aggressive behavior in fish (Suprihatin, 2008). However, the TK7.5 treatment has the highest type II cannibalism value of 23.33±4.62. This is thought to be because the concentration of turmeric flour in the feed given exceeds the optimum point, thus negatively affecting the level of aggressiveness of Asian redtail catfish fry, with an increase in the incidence of cannibals in Asian redtail catfish fry.

In line with type II cannibals, the cannibal index showed the lowest results on the TK5.0 and TK2.5 treatments. In addition to turmeric isoflavone, it also contains curcumin compounds which are phytoestrogens and hepatoprotection. Phytoestrogens can work like estrogen (estradiol-17β) to increase estrogen levels in the blood (Mukai *et al*., 2013). The mechanism of phytoestrogen bioactivity is able to bind to estrogen receptors because it has similar structures with estradiol-17β, although affinity for these receptors tends to be weaker compared to natural estrogen (Zhao & Mu, 2011).

Furthermore, when viewed in terms of normal mortality, it is clear that the control treatment has the highest mortality value. Normal death is a death that is not caused by aggressive behavior and cannibalistic behavior of Asian redtail catfish fry, this death is thought to occur due to the fry having the ability to with certain environmental conditions, possibly related to stocking density, which causes increased stress. In contrast to turmeric flour supplementation treatment this has a lower normal mortality value. This is thought to be because turmeric flour contains curcumin which functions to increase immunity (Anthwal *et al*., 2014; Yonar *et al*., 2019; Ming *et al*., 2020) and anti-stress ability (Akdemir *et al*., 2017) so that Asian redtail catfish fry have a better level of health.

The highest survival rate in this study showed results inversely proportional to the value of the cannibalism index. The highest survival was obtained in the TK5.0 treatment (turmeric flour supplementation of 5.0 g kg^{-1}) which was 53.33±3.06. This treatment showed a 20% increase in survival when compared to the control treatment. This result is thought to be due to the optimal concentration of turmeric flour supplemented in the feed so that it can suppress the aggressiveness of the seeds to prey on each other, as well as improve the health of the Asian redtail catfish seeds. Similar results were reported by Giri *et al*. (2019) who stated that goldfish (*Cyprinus carpio*) given curcumin at a dose of 15 g kg^{-1} for 8 weeks showed significant results with higher survival (69.70%) after being challenged with *Aeromonas hydrophila*, while in the control treatment only

8.34%. In addition, Ming *et al*. (2020) also reported that carp juveniles fed curcumin at a dose of 393.67 mg kg^{-1} had the highest survival after being infected with *A. hydrophila* for 7 days. The same results were also obtained in previous studies, namely in vanamei shrimp (*Litopenaeus vannamei*) (Bhoopathy *et al*., 2021), tilapia (*Oreochromis mossambicus*) (Sruthi *et al*., 2018) and trout (Yonar *et al*., 2019). The results of this study show that turmeric flour supplementation in feed can significantly improve the ability of fish to survive with increased survival.

Growth Performance

Based on the results of research on turmeric flour supplementation in Asian redtail catfish fry feed, shows that the TK2.5 treatment provides lower growth performance than other treatments (P<0.05). However, other treatments did not have a significant impact on growth performance (Table 2, P>0.05)

Table 2. Growth performance for 30 days of maintenance

Parameters	Treatments			
	K	TK2.5	TK5.0	TK7.5
Absolute weight (g/fish)	0.35 ± 0.03^{b}	0.23 ± 0.07^{a}	0.33 ± 0.06^{ab}	0.29 ± 0.02^{ab}
Absolute length (mm/fish)	19.43 ± 2.65^{b}	14.10 ± 2.60^{a}	18.10 ± 1.33^{ab}	19.66 ± 1.64^{b}
SGR (%/day)	3.97 ± 0.17^{b}	2.96 ± 0.62^{a}	3.76 ± 0.46^{b}	3.49 ± 0.16^{ab}
SLR (%/day)	2.19 ± 0.22^{b}	1.71 ± 0.24^{a}	2.08 ± 0.12^{b}	2.21 ± 0.14^{b}

Note: Different superscript letters in the same column behind the mean ± standard deviation indicate significant differences (P<0.05).

Based on Table 2, shows that the absolute weight has a significant difference between treatments (P<0.05), with the highest absolute weight in the control treatment of 0.35±0.03 and the lowest in the TK2.5 treatment of 0.23±0.07. Furthermore, turmeric supplementation may increase the absolute length value at the optimal dose (P<0.05) but does not differ markedly from the control treatment of 19.43±2.65, and the lowest absolute length obtained in the TK2.5 treatment of 14.10±2.60. For SGR there was a difference between treatments (P<0.05), the lowest SGR in the TK2.5 treatment was 2.96±0.62 and the highest in the control treatment was 3.97±0.17 and did not differ markedly from TK5.0 treatment of 3.76±0.46. The SLR parameters showed that turmeric flour supplementation at TK5.0 and TK7.5 treatments could increase SLR by 2.08±0.12 and 2.21±0.14 respectively and did not differ markedly from the control treatment of 2.19±0.22, while the lowest SLR in TK2.5 treatment was 1.71±0.24 (P<0.05).

The absolute weight value and SGR in the turmeric flour addition treatment were lower than the control treatment. This result is thought to be due to the presence of essential oil content in turmeric which causes this ingredient to have a distinctive aroma and taste. According to Syawal *et al.* (2020) one of the disadvantages of natural ingredients such as turmeric is that it has a pungent aroma and bitter taste, so it is less preferred by fish. In line research conducted by Afifah *et al*. (2021) stated that the addition of turmeric by 1% and 1.5% to the feed showed a lower feed consumption value compared to the control treatment, causing a lower growth rate. In addition, the cause of the low absolute weight and SGR in this study was suspected to be due to excess protein in the treatment of adding turmeric flour through the coating, while the control treatment was not added anything. This excess protein causes only part of the protein to be absorbed and used for growth and to form or repair damaged cells, while the excess is excreted in the form of ammonia through the kidneys. This is because excessive protein catabolism will increase specific dynamic action (SDA), namely the use of energy, one of which is to overhaul unused proteins so that energy for growth will be reduced (Kardana *et al*., 2012).

Furthermore, the absolute length and highest SLR values were obtained at the TK7.5 treatment but did not differ markedly from the control treatment. This result is in line with research conducted by Putri (2016), that the addition of turmeric flour up to 3% in carp feed causes the growth rate of fish to decrease, which is suspected to be due to the high level of antinutrient substances in the form of tannins. Different results were revealed in the study of Rojtinnakorn *et al*. (2012), namely the addition of turmeric by 3% showed the highest results on the increase in digestive enzymes in juvenile goby fish (*Oxyeleotris marmoratus*) indicating an increase in growth rate at an advanced level.

Water Quality

Survival and fish growth performance are directly related to water quality (Viadero, 2015). Water quality in this study was measured in the morning and evening and showed no significant fluctuations (Table 3). The

average water temperature was recorded in the range of 26.1-29.0 ^{0}C, dissolved oxygen ranged from 6.2-7.3 mg L^{-1} and pH was at a value of 5.8-6.4. This result is still in good shape to support the maintenance of Asian redtail catfish fry.

Table 3. The results of measuring the water quality of Asian redtail catfish during the study

Parameters	Treatments			
	K	TK2.5	TK5.0	TK7.5
Temperature (^{0}C)	26.3-29.0	26.6-29.0	26.1-29.0	26.5-29.0
Dissolved oxygen (mg L^{-1})	6.3-7.2	6.5-7.2	6.2-7.3	6.3-7.2
pH	5.8-6.4	5.8-6.4	5.8-6.4	5.8-6.4

CONCLUSION

The addition of turmeric flour with the coating method to the feed provides an increase in survival and decreases the value of the cannibalism index and normal mortality, but does not affect the growth of Asian redtail catfish fry.

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