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EFFECT OF FEEDING FREQUENCY OF CHICKEN INTESTINE PASTE ON THE GROWTH AND SURVIVAL OF GLASS CATFISH (*Kryptopterus lais*) FINGERLINGS

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ABSTRACT

This study evaluated the effect of feeding frequency of chicken intestine paste on the growth and survival of *Kryptopterus lais* fingerlings. The experiment utilized a completely randomized design with five feeding frequency treatments (2, 3, 4, 5, and 6 times per day^{-1}) and three replications over 21 days. Ten fingerlings weighing 0.09±0.01 g were stocked in each aquarium and fed at a rate of 10% of their body weight per day. Observed parameters included growth performance, feed efficiency, feed conversion ratio, survival rate, and water quality. The results showed that feeding frequency had a significant effect on growth performance ($P<0.05$). Feeding four times day^{-1} resulted in the best performance, indicated by a weight gain of 0.12±0.01 g, length gain of 1.14±0.21 cm, SGR of 0.57±0.01% day^{-1}, feed efficiency of 47.56±3.45%, feed conversion ratio of 2.48±0.21, and survival rate of 76.67±15.28%, with all water quality parameters remaining within optimal ranges. Therefore, a feeding frequency of four times day^{-1} is recommended to improve growth and feed efficiency during the nursery phase of *Kryptopterus lais*.

KEYWORDS: Chicken intestine paste; feed efficiency; feeding frequency; growth performance; *Kryptopterus lais*

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi pengaruh frekuensi pemberian pakan berbasis pasta usus ayam terhadap pertumbuhan dan kelulushidupan benih ikan selais (*Kryptopterus lais*). Penelitian menggunakan rancangan acak lengkap dengan lima perlakuan frekuensi pemberian pakan (2, 3, 4, 5, dan 6 kali hari^{-1}) dan tiga ulangan selama 21 hari. Sebanyak 10 ekor benih dengan bobot 0,09±0,01 g ditebar pada masing-masing akuarium dan diberi pakan sebesar 10% dari bobot tubuh. Parameter yang diamati meliputi pertumbuhan, efisiensi pakan, rasio konversi pakan, kelulushidupan, dan kualitas air. Hasil penelitian menunjukkan bahwa frekuensi pemberian pakan berpengaruh nyata terhadap performa pertumbuhan ($P<0,05$). Frekuensi pemberian pakan empat kali hari^{-1} menghasilkan kinerja terbaik, ditunjukkan oleh pertambahan bobot mutlak 0,12±0,01 g, pertambahan panjang mutlak 1,14±0,21 cm, LPS 0,57±0,01% hari^{-1}, efisiensi pakan 47,56±3,45%, rasio konversi pakan 2,48±0,21, serta kelulushidupan 76,67±15,28%, dengan kualitas air tetap berada dalam kisaran optimal. Dengan demikian, frekuensi pemberian pakan empat kali hari^{-1} direkomendasikan sebagai frekuensi optimal untuk meningkatkan pertumbuhan dan efisiensi pakan pada fase pendederan ikan selais.

KATA KUNCI: Efisiensi pakan; frekuensi pakan; *Kryptopterus lais*; pasta usus ayam; pertumbuhan

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INTRODUCTIONS

Kryptopterus lais, commonly known as glass catfish, is a freshwater fish species of significant economic importance, valued both as a food source and as an ornamental fish. The demand for this species has continued to increase in line with strong domestic and international market interest, which has consequently intensified fishing pressure on its natural populations (Efrizal *et al.*, 2023; Rosyadi *et al.*, 2025). This condition has raised concerns regarding the decline of *K. lais* populations, which may threaten its sustainability in the wild (Nurmayani *et al.*, 2020; Thamrin, 2020). To ensure the sustainability of this species, aquaculture has emerged as a promising strategy. The cultivation of *K. lais* not only reduces pressure on wild populations but may also increase fish production while preserving product quality (Leksono *et al.*, 2020; Arisuryanti *et al.*, 2020).

However, the intensification of *K. lais* culture is accompanied by an increasing demand for high-quality feed, which often contributes substantially to operational costs. Therefore, the development of alternative feeds based on locally available raw materials, such as chicken intestine waste, has become an attractive option (Ikhfanisa *et al.*, 2024). Chicken intestine meal has been reported to contain 63.48% protein, 14.35% lipid, 12.75% ash, and 11.40% carbohydrate (Cruz *et al.*, 2009; Seong *et al.*, 2015; Wu *et al.*, 2022), values that are comparable to those of fish meal, making it a potential feed ingredient for aquaculture species (Yoel *et al.*, 2016). In addition, the characteristic odor and texture of chicken intestine may improve feed palatability for fish (Ikhfanisa *et al.*, 2024).

Efficient and optimal feed management is a critical component of commercial aquaculture, given that feed cost represents the largest proportion of production expenditure (Vassiliou *et al.*, 2015). Although nutritionally balanced diets have been widely formulated for cultured fish, appropriate feeding strategies are still required to maximize production efficiency (Baloi *et al.*, 2014). In this regard, feeding frequency plays an important role in promoting feed intake, improving digestive efficiency, and ultimately affecting fish growth and survival.

Studies on optimal feeding frequency in aquaculture species have shown that a higher feeding frequency may improve growth performance during early developmental stages (Biswas *et al.*, 2006). However, excessive feeding may reduce feed conversion efficiency and adversely affect water quality (Baloi *et al.*, 2014). Conversely, low feeding frequency may result in uneven growth and increase the risk of cannibalism (Booth *et al.*, 2008). To date, however, no study has specifically evaluated the feeding frequency of chicken intestine paste in *K. lais* fingerlings. Therefore, the present study investigated the effect of varying feeding frequencies of chicken intestine paste on the growth and survival of glass catfish (*Kryptopterus lais*) fingerlings.

MATERIALS AND METHODS

Feed Ingredients and Diet Formulation

The main ingredients used to prepare the experimental paste diet were chicken intestine meal and rice bran. Chicken intestines were obtained from a poultry slaughterhouse located at Pasar Syariah Ulul

Table 1. Formulation of the experimental diets

Ingredients	Composition (% dry matter)
Chicken intestine meal	69
Rice bran	25
Fish oil	2
Vitamin mix[1]	2
Mineral mix[2]	2
Proximate analysis	
Crude Protein	34.98
Lipid	5.39
Crude fiber	1.49
Ash	18.50
NFE[3]	39.64
Energy (DE kcal 100 g^{-1})[4]	265.19

[1] The vitamin mixtures utilized in this study were prepared according to the formulation described by Hadi *et al.* (2024).
[2] The mineral mixtures utilized in this study were prepared according to the formulation described by Hadi *et al.* (2024).
[3] The NFE is determined according to the formula utilized by Hadi *et al.* (2024).
[4] Digestible energy (DE kcal g^{-1}) is calculated using the following values: crude protein = 3.5 kcal g^{-1}, fat = 8.1 kcal g^{-1}, and nitrogen-free extract (NFE) = 2.5 kcal g^{-1}.

Table 2. Proximate composition of chicken intestine meal

Parameters (%)	Chicken intestine meal
Moisture content	7.06
Crude protein	45.27
Lipid	5.44
Ash	2.25
Carbohydrates	39.98

Source: Nawa Agna Laboratory, PT. Nawa Agna, Bogor

Albab, Siak Hulu District, Kampar, Riau. Prior to use, the intestines were thoroughly washed to remove impurities. They were then sun-dried for five days until completely dried. After drying, the intestines were ground and sieved to produce chicken intestine meal (Ikhfanisa *et al.*, 2024). In this study, approximately 3.6 kg of fresh chicken intestines were required to produce 1 kg of chicken intestine meal. The proximate composition of the chicken intestine meal is presented in Table 2. In addition, rice bran was also sieved to obtain a finer particle size.

The preparation of the paste diet began by weighing chicken intestine meal and rice bran, followed by the addition of fish oil, vitamins, and minerals according to the formulation shown in Table 1. The ingredients were then mixed thoroughly until homogeneous, and water equivalent to 50% of the mixture weight was gradually added until a uniform paste was formed (Hadi *et al.*, 2024). Feed quality was maintained by storing it in a freezer at -20°C and thawing it at room temperature for approximately 15 minutes prior to feeding the fish.

Experimental Fish and Feeding Trial

The experimental fish used in this study were glass catfish (*Kryptopterus lais*) fingerlings obtained from the Fish Hatchery Unit of Universitas Islam Riau (UIR). The fingerlings had an average initial body weight of 0.09±0.01 g and an average total length of 2.38±0.02 cm, with a total of 300 fish used in the experiment. The fish were randomly distributed into 15 aquaria (30 × 24 × 18 cm), each containing 5 L of water, at a stocking density of 10 fish per aquarium (2 fish L^{-1}). The fish were fed daily at 10% of their body weight (Rosyadi & Agusnimar, 2016), with feeding frequencies adjusted according to the treatment assigned. The treatments were as follows: feeding twice daily (07:00 and 19:00 WIB), three times daily (08:00, 14:00, and 20:00 WIB), four times daily (08:00, 12:00, 16:00, and 20:00 WIB), five times daily (09:00, 12:00, 15:00, 18:00, and 21:00 WIB), and six times daily (09:00, 11:00, 13:00, 15:00, 17:00, and 19:00 WIB).

Experimental Design

The study employed a completely randomized design with five feeding frequency treatments, namely feeding 2, 3, 4, 5, and 6 times per day. Each treatment was conducted in triplicate.

Proximate Analysis of the Experimental Diet

The proximate composition of the experimental diet was analyzed using standard AOAC (2005) procedures at the Nawa Agna Laboratory, PT. Nawa Agna, Bogor. Crude protein content was determined using the Kjeldahl method, lipid content by Soxhlet extraction, ash content by combustion in a muffle furnace at 500-550°C for 6 h, moisture content by oven-drying at 105°C for 24 h, crude fiber by acid digestion, and carbohydrate content by the difference method.

Water Quality Management

Water quality was maintained by siphoning feces and feed residues every two days. Siphoning was carried out in the afternoon to minimize stress in the experimental fish. Water quality parameters were assessed at seven-day intervals, including temperature, pH, dissolved oxygen, and ammonia. Temperature and pH were determined using a pH meter (H198108). Dissolved oxygen was measured with a DO meter (Lutron PDO-519), and ammonia concentrations were quantified using an ammonia meter MR (HI715).

Sampling Procedure

Sampling was conducted on days 0, 7, 14, and 21. Before sampling, a plastic container filled with water from the culture medium was prepared to temporarily hold the fish during measurement, thereby minimizing stress due to sudden environmental changes. The fish were carefully collected using a fine scoop net and transferred individually into the sampling container.

Body weight was measured individually using a digital balance with an accuracy of 0.01 g. Each fish was weighed separately, and the results were recorded. Total length was measured using millimeter block paper with an accuracy of 1 mm. The fish was placed in a straight position on the measuring surface, and total length was recorded from the tip of the snout to the end of the caudal fin. After measurement, the fish were immediately returned to their respective aquaria according to treatment.

All fish in each aquarium were observed at every sampling time to obtain data on body weight, body length, and the number of surviving fish. These data were used to calculate weight gain, length gain, and survival rate. All sampling procedures were performed rapidly and carefully to minimize stress.

The growth performance, feed utilization, and survival rates of *K. lais* fingerlings were determined using the equations established by Rosyadi *et al.* (2025) and Agusnimar *et al.* (2025), as detailed below:

Absolute weight gain (g) = final weight - initial weight

Absolute length gain (cm) = final length - initial length

Specific growth rate (%) = 100 × [ln final weight - ln initial weight] / time (days)

Feed efficiency (%) is calculated as 100 multiplied by the difference between the sum of the final weight and the weight of dead fish and the initial weight, divided by total feed consumption.

Feed conversion ratio is calculated as the total feed consumption divided by the difference between the sum of final fish biomass and the weight of dead fish, and the initial fish biomass.

Survival rate (%) = 100 × (number of fish at the end / number of fish at the beginning)

Statistical Analysis

Mean values (n = 3) were reported for all data. Statistical analyses were conducted using SPSS version 24.0 (IBM, Chicago, IL, USA). Homogeneity of variance among treatments was assessed prior to performing one-way analysis of variance (ANOVA) to evaluate treatment effects Duncan's multiple range test was subsequently applied. Statistical significance was defined as $P < 0.05$.

RESULTS AND DISCUSSIONS

Table 3 presents the weight gain, length gain, and specific growth rate of glass catfish after 21 days of rearing. The average growth responses in body weight and total length during the experimental period are shown in Figure 1. Feeding frequency of chicken intestine paste significantly affected the growth performance of glass catfish (*Kryptopterus lais*) ($P < 0.05$). Feeding four times daily produced the highest values for absolute weight gain (0.12±0.01 g), absolute length gain (1.14±0.21 cm), and specific growth rate

Table 3. Growth performance of glass catfish after being fed chicken intestine paste at different frequencies

Parameters	Feeding frequency (times day^{-1})				
	2	3	4	5	6
Initial weight (g)	0.09±0.00	0.09±0.00	0.09±0.00	0.09±0.00	0.09±0.00
Initial length (cm)	2.38±0.00	2.38±0.00	2.38±0.00	2.38±0.00	2.38±0.00
Final weight (g)	0.17±0.02^{a}	0.19±0.01^{a}	0.21±0.01^{b}	0.19±0.01^{a}	0.19±0.01^{a}
Final length (cm)	3.18±0.20^{a}	3.26±0.10^{a}	3.52±0.21^{b}	3.42±0.20^{a}	3.31±0.21^{a}
Absolute weight (g)	0.08±0.02^{a}	0.09±0.01^{a}	0.12±0.01^{b}	0.10±0.01^{a}	0.10±0.01^{a}
Absolute length (cm)	0.80±0.20^{a}	0.88±0.10^{a}	1.14±0.21^{b}	1.04±0.20^{a}	0.93±0.21^{a}
Specific growth rate (%)	0.40±0.02^{a}	0.46±0.01^{a}	0.57±0.01^{b}	0.49±0.01^{a}	0.46±0.01^{a}

Note: Values are presented as mean ± standard deviation. Distinct letters within the same row denote statistically significant differences ($P < 0.05$)

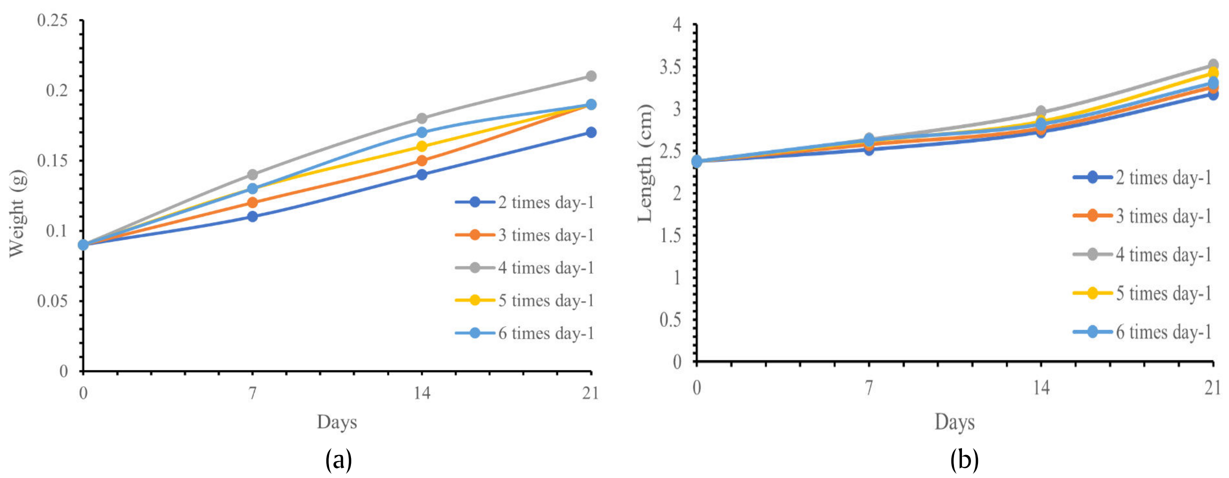

Figure 1. Growth response in weight (a) and length (b) of glass catfish after being fed chicken intestine paste at different frequencies

(0.57±0.01%), which were significantly different from those of the other treatments ($P < 0.05$). These results indicate that increasing feeding frequency can improve fish growth; however, there is an optimal threshold beyond which further increases no longer provide significant benefits (Hanief *et al.*, 2014).

The use of chicken intestine paste as an alternative feed was shown to be effective in supporting the growth of glass catfish. Previous studies have reported that chicken intestine meal or paste can partially replace fish meal in aquafeed formulations without causing significant reductions in growth performance. Therefore, chicken intestine paste appears to be a feasible protein source for promoting the growth of glass catfish, while also offering economic and sustainability advantages for aquaculture production (Sukma *et al.*, 2019; Komariyah *et al.*, 2024).

Comparisons with previous studies indicate that the optimal feeding frequency varies depending on fish species and feed type. A study on striped catfish reported that feeding three times daily resulted in optimal growth (Husain *et al.*, 2015), whereas in the present study, four feedings per day were more suitable for glass catfish fingerlings. These differences may be attributed to species-specific characteristics, feed type, and environmental conditions. In addition to these factors, fish age and feeding frequency have also been reported to influence growth responses (Saputra *et al.*, 2018). Likewise, a study on tawes fish demonstrated that feeding three to four times daily resulted in the best growth performance (Hanief *et al.*, 2014), which supports the present finding that each fish species has a specific optimal feeding frequency.

Thus, feeding chicken intestine paste four times per day may be considered the optimal feeding frequency for promoting the growth of glass catfish. Chicken intestine paste has demonstrated effectiveness and applicability as an alternative feed for this species. These results align with previous studies emphasizing the significance of optimal feeding frequency and feed quality in supporting aquaculture fish growth (Komariyah *et al.*, 2024).

Based on Table 4, feeding frequency of chicken intestine paste significantly affected feed efficiency and feed conversion ratio of glass catfish ($P < 0.05$). The treatment with a feeding frequency of four times daily produced the highest feed efficiency (47.56±3.45%) and the lowest feed conversion ratio (2.48±0.21), indicating the most efficient feed utilization among all treatments. This finding is in agreement with previous studies reporting that moderate to relatively high feeding frequencies, approximately three to four times per day, improve feed utilization efficiency and reduce feed conversion ratio in several cultured fish species (Haruna *et al.*, 2014; Abdel-Aziz *et al.*, 2016). A lower feed conversion ratio indicates that feed is more efficiently converted into fish biomass, thereby improving aquaculture productivity. In addition, the highest survival rate was also observed in fish fed four times daily (76.67±15.28%), although the differences among treatments were not statistically significant ($P > 0.05$).

Nevertheless, the absolute weight gain observed in this study was still relatively low. The highest absolute weight gain reached only 0.12±0.01 g over the 21-day rearing period, whereas the highest absolute length gain reached 1.14±0.21 cm. This condition was likely associated with the very small initial size of the fingerlings (0.09±0.01 g), such that most of the dietary energy was first allocated to basal metabolism, activity, and maintenance before being used for tissue formation. At the fingerling stage, fish are also generally more sensitive to environmental changes and feed quality, which may limit optimal weight gain. In addition, the paste form of the diet may have caused part of the nutrients to leach into the culture medium before being fully consumed, thereby reducing feed utilization efficiency.

From a nutritional perspective, the results of this study also emphasize the importance of optimal dietary protein content. The experimental diet contained 34.98% crude protein and 5.39% lipid. Protein is the major nutrient required for growth, but each fish species has its own optimal protein requirement. If dietary protein is below the requirement, growth will be constrained. Conversely, when protein is supplied in excess of the requirement, the surplus is not fully used for growth but instead is deaminated and excreted into the aquatic environment as nitrogenous waste (Rosyadi *et al.*, 2025). This differs from lipid, which is more readily stored in the body as an energy reserve, although its dietary level must also remain within the optimal range for each species. Therefore, a high dietary protein level does not necessarily result in higher growth if it does not match the physiological requirement of glass catfish fingerlings.

These findings align with previous research indicating that the growth and nutrient utilization of glass catfish larvae are significantly affected by dietary protein level, with an optimal protein level that yields the best performance (Rosyadi *et al.*, 2025). Those studies demonstrated that both insufficient and excessive dietary protein may reduce nutrient utilization efficiency. In addition, other reports have shown that the growth of glass catfish is affected by the type of feed provided (Rosyadi & Agusnimar, 2016), whereas improvement in artificial feed quality can enhance

Table 4. Feed utilization and survival of glass catfish after being fed chicken intestine paste at different frequencies

Parameters	Feeding frequency (times day^{-1})				
	2	3	4	5	6
Total feed consumption (g)	2.27±0.30^a	5.16±2.10^b	5.00±1.29^b	4.99±1.45^b	5.74±0.87^b
Feed efficiency (%)	26.85±1.11^a	29.00±1.37^a	47.56±3.45^b	32.57±9.29^a	29.98±1.43^a
Feed conversion ratio	5.23±0.26^a	4.19±0.30^a	2.48±0.21^b	3.89±1.34^a	4.09±0.38^a
Survival rate (%)	53.33±5.77	60.00±10.00	76.67±15.28	66.67±15.28	63.33±5.77

Note: Values are presented as mean ± standard deviation. Distinct letters within the same row denote statistically significant differences ($P < 0.05$)

Table 5. Water quality of the glass catfish maintenance medium during the 21-day experiment

Parameters	Feeding frequency (times day^{-1})				
	2	3	4	5	6
Temperature (°C)	25-27	26-28	25-28	25-27	26-28
pH	6.82-7.23	6.82-7.20	6.82-7.24	6.82-7.21	6.82-7.22
Dissolved oxygen (mg L^{-1})	6.5-6.7	6.0-6.7	6.6-6.7	6.3-6.7	6.3-6.7
Ammonia (mg L^{-1})	0.30-0.53	0.32-0.53	0.28-0.53	0.31-0.53	0.31-0.53

growth performance (Efrizal *et al.*, 2023). Taken together, the present results confirm that a feeding frequency of four times daily was the most effective under the conditions of this study, although further improvement in fingerling growth may still be achieved through refinement of dietary nutrient composition, particularly protein level and energy balance.

Overall, feeding chicken intestine paste four times daily was the best treatment for supporting growth, feed efficiency, and feed conversion ratio in glass catfish fingerlings. However, further studies are still needed to achieve greater growth performance, particularly through optimization of dietary protein and lipid levels according to the nutritional requirements of glass catfish fingerlings. These findings indicate that chicken intestine paste has strong potential as an alternative feed ingredient in the culture of glass catfish because it is relatively economical, readily available, and capable of supporting growth performance with reasonable efficiency.

During the 21-day rearing period, water quality parameters, including temperature (25-28°C), pH (6.82-7.24), dissolved oxygen (6.0-6.7 mg L^{-1}), and ammonia concentration (0.28-0.53 mg L^{-1}), remained within the optimal range for glass catfish survival and growth, as presented in Table 5. These parameters align with previously recommended ranges for the culture of this species (Mulyadi *et al.*, 2010; Hridoy *et al.*, 2025).

CONCLUSIONS

The results indicate that the feeding frequency of chicken intestine paste significantly influences the growth performance of glass catfish (*Kryptopterus lais*) fingerlings. Feeding the fish four times daily produced the best performance, as indicated by an weight gain of 0.12±0.01 g, an length gain of 1.14±0.21 cm, a specific growth rate of 0.57±0.01%, a feed efficiency of 47.56±3.45%, a feed conversion ratio of 2.48±0.21, and a survival rate of 76.67±15.28%. Therefore, feeding four times per day is recommended as the optimal feeding frequency to improve growth and feed utilization efficiency in glass catfish fingerlings.

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