

The Effect of Different Natural Feed Types on the Gonadal Maturity of Asiatic Snakehead (*Channa asiatica*)

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ABSTRACT

The Asiatic snakehead (*Channa asiatica*) is a freshwater ornamental fish of high economic value, but its cultivation is constrained by low reproductive productivity, which is strongly influenced by the quality of broodstock feed. This study aimed to evaluate the effect of different types of natural feed on the gonadal maturity of *C. asiatica*. The research applied a completely randomized design (CRD) with three treatments and three replications: earthworm (*Lumbricus rubellus*, P1), mealworm (*Tenebrio molitor*, P2), and freshwater shrimp (*Macrobrachium sintangense*, P3), each given at 5% of the fish biomass twice daily for 30 days. The observed variables were the gonadosomatic index (GSI), gonad index (GI), hepatosomatic index (HSI), survival rate, and water quality. Data were analyzed using one-way ANOVA followed by Duncan's multiple range test at $\alpha = 0.05$. Descriptively, the earthworm treatment (P1) produced the highest mean values of GSI (2.00%), GI (0.0300×10^7), and HSI (1.80%); however, ANOVA revealed no significant differences among treatments for any variable ($p > 0.05$), and all treatments fell within the same Duncan subset. The survival rate ranged from 80–100% and water

quality remained within suitable ranges throughout the study. These findings indicate that, under the tested conditions, the three natural feed types provided a comparable contribution to the gonadal maturation of *C. asiatica*, with earthworm showing a consistent tendency toward higher values.

INTRODUCTION

The development of ornamental fish farming in Indonesia continues to grow, particularly for native freshwater ornamental fish, which have become an alternative source of income for both fish farmers and ornamental fish entrepreneurs (Talahatu, 2025). The economic value of ornamental fish tends to increase every year, so that good aquaculture management can support improvements in community welfare (Setiawan, 2019). One of the most sought-after ornamental fish is the small snakehead, or ornamental snakehead fish (*Channa asiatica*), which originates from China (Akbar, 2022). Its natural habitat includes humid areas such as rainforests, ponds, lakes, and calm river streams. This species is distributed throughout the Yangtze River valley and the Xun River in Guangxi and Guangdong Provinces, and is also found in Taiwan and southern Japan, particularly on Ishigaki Island (Mahamaya, 2019).

The high demand for this fish has not been matched by adequate productivity. The growth and reproduction of snakehead fish are influenced by external factors such as feed quality and environmental conditions, as well as internal factors such as behavior, age, and the hormonal system (Herliwati *et al.*, 2024). Feed is a crucial factor for both the growth and the gonadal maturation of broodstock (Ibrahim *et al.*, 2020). Several types of natural feed are known to have relatively high protein content and therefore have the potential to support the protein requirements of broodstock, including earthworm (*Lumbricus rubellus*) with a protein content of approximately 76% (Anugrah & Alamsyah, 2021), mealworm (*Tenebrio molitor*) with a crude protein content of 37.80% (Iding *et al.*, 2020), and freshwater shrimp (*Macrobrachium sintangense*) with a protein content of approximately 41.67% (Novitria, 2017).

An increase in the protein content of the broodstock body can accelerate gonadal maturation and enhance the gonadosomatic index, fecundity, and egg quality (Maulidiyah *et al.*, 2025). Ghaedi *et al.* (2019) reported that *Channa* fed high-protein diets of up to 45% had a greater gonadosomatic index, larger egg diameter, and higher fecundity compared with low-protein treatments. Similar results were obtained by Wijianti *et al.* (2018), who found that a combination of protein levels of 37–43% with a specific protein–energy ratio produced optimal growth while also supporting gonadal development in *Channa*.

The provision of appropriate feed with adequate protein content determines gonad quality and the success of producing superior seed. Although the effectiveness of feed on the growth of cultured fish has been widely studied, information regarding the effect of feed type on the gonadal maturity of *C. asiatica* remains limited. Therefore, this study aimed to determine the effect of providing different types of natural feed—earthworm, mealworm, and freshwater shrimp—on the gonadal maturity of *C. asiatica*, as measured through the gonadosomatic index (GSI), gonad index (GI), and hepatosomatic index (HSI).

METHODS

Time and Place of the Study

The study was conducted over a two-month period at Acen Aquatic Farm from August to September 2025. The study used an experimental method with a completely randomized design (CRD) consisting of three treatments and three replications, resulting in nine experimental units.

Treatment Design

The treatments applied consisted of differences in the type of natural feed (Nguyen & Yang, 2007; Istiqomah *et al.*, 2009; Henry *et al.*, 2015), namely P1 (earthworm, *Lumbricus rubellus*), P2 (mealworm, *Tenebrio molitor*), and P3 (freshwater shrimp, *Macrobrachium sintangense*). Earthworms and mealworms were purchased from local livestock feed dealer, while freshwater shrimp were collected from the wild in purchased from local fish market. All feed organisms were held in the laboratory for 24 hours without feeding to allow gut evacuation before being offered to the fish. Feed was provided at 5% of fish biomass, twice daily at 09:00 and 14:00 Western Indonesia Time (WIB).

Research Procedure

The containers used were nine aquaria measuring 70 × 35 × 40 cm, each stocked with 10 fish. The test fish, *Channa asiatica* with an average total length of 12–13 cm, were obtained from cultured stock at Acen Aquatic farm, Magelang, and were selected based on the criteria of being healthy, active, and free of physical defects. Prior to rearing, the fish were acclimatised for 2 days, then individually measured and weighed to obtain initial length and weight; the same measurements were repeated after 30 days of rearing. Water quality was measured every morning and evening, and siphoning was performed every two weeks to remove uneaten feed and faeces so that ammonia concentrations remained stable.

Observed Parameters

The gonadosomatic index (GSI) was calculated by comparing gonad weight with fish weight, following Effendie (1979): $GSI = (Bg/Bt) \times 100\%$, where Bg is gonad weight (g) and Bt is fish weight (g).

The gonad index (GI) was calculated following Tan & Tan (2002) in Alamsyah *et al.* (2013):

$$GI = (W/L^3) \times 10^7, \text{ where } W \text{ is gonad weight (g) and } L \text{ is fish length (cm)}$$

The hepatosomatic index (HSI) was calculated following Sadekarpawar & Parikh (2013):

$$HSI = (Bh/Bt) \times 100\%, \text{ where } Bh \text{ is liver weight (g) and } Bt \text{ is fish weight (g)}$$

The water quality parameters observed included temperature, pH, and dissolved oxygen (DO).

Data Analysis

The GSI, GI, and HSI data were analyzed using one-way analysis of variance (ANOVA) at a significance level of $\alpha = 0.05$. Where a significant treatment effect was found, it was followed by Duncan's multiple range test. Survival and water quality data were analyzed descriptively.

RESULTS

The mean values of GSI, GI, and HSI of *C. asiatica*, together with the results of the analysis of variance, are presented in Table 1. Descriptively, the highest values for all three variables were obtained in treatment P1 (earthworm). Nevertheless, the ANOVA results showed that the difference in feed type had no significant effect on GSI ($F = 0.52$; $p = 0.619$),

GI ($F = 0.115$; $p = 0.893$), or HSI ($F = 2.63$; $p = 0.151$). Duncan's follow-up test placed all treatments in the same subset, so they did not differ significantly from one another (indicated by the same letters).

Table 1. Mean Values of GSI, GI, and HSI (Mean $\pm$ Standard Deviation) of *Channa asiatica* During the Rearing Period

Treatment	GSI (%)	GI ($\times 10^7$)	HSI (%)
P1 (Earthworm)	2.00 $\pm$ 1.11 ^a	0.0300 $\pm$ 0.0173 ^a	1.80 $\pm$ 0.23 ^a
P2 (Mealworm)	1.43 $\pm$ 0.39 ^a	0.0233 $\pm$ 0.0231 ^a	1.59 $\pm$ 0.25 ^a
P3 (Freshwater shrimp)	1.76 $\pm$ 0.14 ^a	0.0267 $\pm$ 0.0058 ^a	1.31 $\pm$ 0.29 ^a
F-value	0.52	0.115	2.63
p-value	0.619	0.893	0.151

Note: The same superscript letters within the same column indicate no significant difference based on Duncan's test ($\alpha = 0.05$); $n = 3$ replications per treatment.

The survival rate of *C. asiatica* during the rearing period ranged from 80–100% (Table 2). Mortality occurred only in one replication of treatment P3.

Table 2. Survival Rate of *Channa asiatica* (%) During the Rearing Period

Treatment	R1	R2	R3
P1	100	100	100
P2	100	100	100
P3	100	100	80

The water quality parameters during the study were within the suitable range for rearing *C. asiatica* (Table 3). Temperature ranged from 24–29 °C, pH from 6.7–7.7, and DO from 4.3–8.0 ppm.

Table 3. Water Quality Parameters of the Rearing Medium

Parameter	P1	P2	P3	Suitable Range
Temperature (°C)	24–29	25–29	25–29	20–30
pH	6.7–7.6	6.7–7.7	6.8–7.6	6.0–8.5
DO (ppm)	4.3–8.0	4.6–7.9	4.6–7.8	>5

DISCUSSION

Feed serves as a source of energy for body maintenance, the replacement of damaged tissue, growth, and activity, with any excess being used for reproduction (Sitanggang, 2014). During the seed-rearing phase, natural feed is highly suitable because it has sufficient nutrient content, a size appropriate to the fish's mouth gape, is easily digestible, and its movement attracts the fish's attention (Rihi, 2019; Taufiqurahman *et al.*, 2017).

Descriptively, the GSI values in this study ranged from 1.43–2.00%, with the highest value in treatment P1 (earthworm). This tendency is thought to be related to the tocopherol and vitamin E content of earthworm, which act as antioxidants to stimulate the reproductive process (Susanti & Mayudin, 2012). Feed quality plays a significant role in the process of gonadal maturation (Pujianti *et al.*, 2014); appropriate nutrient content affects the duration of spawning and egg quality (Siswanto *et al.*, 2016). Quality feed containing essential amino

acids such as leucine, lysine, arginine, valine, threonine, and phenylalanine (Dayat *et al.*, 2003) is required for body maintenance, growth, gonadal maturation, and embryonic development, and is also important for endocrine functions such as estrogen, which stimulates the process of vitellogenesis in the liver (Purvaneswari *et al.*, 2009). The protein content of feed strongly influences the synthesis of estrogen in the gonads and of vitellogenin in the liver (Berg *et al.*, 2004).

Nevertheless, the ANOVA results showed that the difference in feed type had no significant effect on GSI, GI, or HSI ($p > 0.05$), and Duncan's test placed all treatments in the same subset. In other words, the three types of natural feed made a comparable contribution to the gonadal maturity of *C. asiatica* under the conditions of this study. This is likely due to the protein content of the three feeds, all of which were relatively high (37–76%) and thus sufficient to meet the nutritional requirements for gonadal development, as well as to the short rearing period (30 days) and the relatively large variability among replications—reflected in the high standard deviation of GSI in P1 (± 1.11). These factors reduced the likelihood of detecting a statistically significant difference despite the descriptive tendency.

The highest GI value was also found in treatment P1 (0.0300×10^7). In addition to using body weight, the assessment of gonadal maturity can also employ the total length of the fish, so the gonad index is generally calculated on the basis of a comparison with body length. The GI pattern, which was consistent with the GSI, reinforces the interpretation that gonadal development in all three treatments proceeded at a comparable level.

The results also showed a consistent pattern between the hepatosomatic index and the gonadal maturity level, with the highest HSI value in treatment P1 (1.80%). Tresnati *et al.* (2018) reported that the greater the gonadal maturity, the greater the HSI value. During ovarian development, the HSI increases rapidly and then declines toward the end of maturation. The hepatosomatic index reflects the phase of gonadal development because the liver is the site of yolk formation through the process of vitellogenesis, which is characterized by an increase in yolk volume (Fujaya, 2008). The higher the percentage of GSI, the greater the energy required for gonadal development (Yuniati *et al.*, 2023), while the energy reserves in the liver are also used to maintain body metabolism (Yin *et al.*, 2009). Nonetheless, the difference in HSI among treatments in this study did not reach a statistically significant level ($p = 0.151$).

The high survival rate (80–100%) indicates that the three types of feed were well accepted by the test fish. The water quality parameters during the study, temperature of 24–29 °C, pH of 6.7–7.7, and DO of 4.3–8.0 ppm were within suitable ranges and therefore did not become limiting factors for either growth or gonadal development. These stable environmental conditions also supported the health of the fish during the rearing period.

CONCLUSION

The provision of different types of natural feed (earthworm, mealworm, and freshwater shrimp) did not produce significantly different effects on the gonadosomatic index, gonad index, and hepatosomatic index of *Channa asiatica* ($p > 0.05$) under the 30-day rearing conditions. Descriptively, the earthworm treatment tended to produce the highest values of GSI (2.00%), GI (0.0300×10^7), and HSI (1.80%), and thus has the potential to be a preferred feed for supporting gonadal maturation. The survival rate of the fish was high (80–100%), and water quality remained within suitable ranges. Further research with a longer rearing period

and a larger number of replications is needed to clarify the effect of feed type on the gonadal maturity of *C. asiatica*.

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