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The Effect of Different Live Feeds on the Growth Performance of Wild Betta *Betta channoides* Fry

Andri Iskandar [1*], Wahyu Dwi Setiawan [1], Asep Permana [2], and Cecilia Eny Indriastuti [1]

[1] Study Program of Technology and Management of Applied Aquaculture, College of Vocational Studies, IPB University, Bogor, Indonesia 16128

[2] National Research and Innovation Agency

[*] Correspondence author:
Andri Iskandar
andriiskandar@apps.ipb.ac.id
Kumbang St. No.14, Bogor City, Indonesia. 16128

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Abstract

The wild betta fish, *Betta channoides*, is an endangered species native to East Kalimantan, Indonesia. Its population is declining due to habitat destruction caused by the construction of the new capital, deforestation for oil palm plantations, and overfishing for trade. To conserve *Betta channoides*, domestication is necessary. Since 2019, the Depok Ornamental Fish Cultivation Research Institute has been working on breeding this species. However, larvae growth has remained a challenge, partly due to a need for knowledge about the best live feeds. This study aims to improve the development of Betta channoides larvae using different live feeds. The experiment used a completely randomized design (CRD) with four treatments and three replicates: Artemia sp. (K), bloodworms (CD), silkworms (CS), and water fleas (KA). Data were analysed using SPSS with Duncan's test and the Kruskal-Wallis test. The results showed that larvae fed with silkworms had the best outcomes, with an absolute length growth of 0.780±0.020 cm, weight growth of 0.272±0.005 g, and a survival rate of 93.33±5.773%. The silkworms treatment significantly outperformed the other feeds. The study concludes that different feeds significantly affect the growth and survival of *Betta channoides* larvae, with silkworms providing the best results.

Keywords: *Betta channoides*, declining population, domestication, growth performance, live feeds.

I. INTRODUCTION

Wild betta *Betta channoides* is a fish species native to Indonesia, found explicitly in East Kalimantan. Its natural habitat includes rivers in Samarinda, particularly the Mampang, Melak, and Badak rivers. This species is known for its striking and attractive colors, with heads resembling those of snakes. Permana *et al.* (2021) mentioned that typically, male *Betta channoides* display brighter colors, with a brownish-red hue and white stripes on their fins, while females have a paler appearance and lack the white stripes (Figure 1).

Betta channoides command a relatively high price in the ornamental fish market, with pairs selling for around IDR 80,000. However, most of the fish sold are sourced from wild catches. Currently, *Betta channoides* is classified as a species threatened with extinction due to a declining population caused by environmental damage to its natural habitat (Permana *et al.*, 2021). This damage is driven by the construction of the new

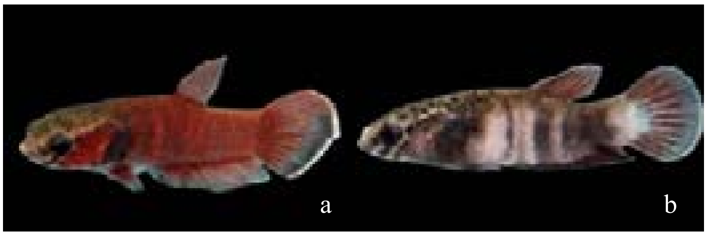

Figure 1. *Betta channoides* (a) male (b) female.

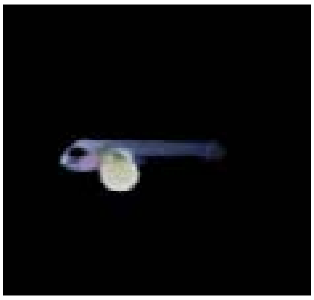

Figure 2. *Betta channoides* larvae

capital city in East Kalimantan, deforestation of oil palm plantations, and overfishing to meet trade demands. To preserve the existence of *Betta channoides* in the wild and meet the need of the ornamental fish trade, domestication efforts are necessary. Depok Ornamental Fish Cultivation Research Institute has been working on cultivating this species since 2019. However, one of the current challenges is the suboptimal growth of larvae due to the need for more knowledge about the most suitable live feeds for accelerating fish growth.

Food availability is a critical factor in the success of fish farming. According to Ramadhan (2021), two main types of feed are commonly used in aquaculture: live feeds and artificial. Live feeds include food from nature, such as plankton, small invertebrates, and algae found in fish habitats. It is particularly suitable for the larval rearing stage due to its complex, balanced nutritional content, appropriate size for the larvae's mouth, attractive color, and ease of digestion and also helps fish adapt to their new environment and reduces stress (Conceição *et al*., 2010).

Providing proper feed for larvae is essential for achieving optimal growth. The growth and development of betta fish require vital nutrients such as protein, fat, carbohydrates, minerals, and vitamins (Febri, 2016). These nutrients can be sourced from various types of life feeds, including bloodworms, silkworms, water fleas, and brine shrimp. This study aims is to enhance the growth of wild betta *Betta channoides* larvae by providing different types of live feeds.

II. MATERIALS AND METHODS

2.1 Experimental Design and Animal Wild Betta Betta channoides

The research utilized a Completely Randomized Design (CRD) with four treatments and three repetitions. The treatments included the addition of bloodworms Chironomus larvae (CD), silkworms *Tubifex* sp. (CS), water fleas *Daphnia* sp. (KA), and administration of *Artemia* sp. as control (K). Larvae rearing was conducted in jars measuring 20 × 20 cm, each with a 5 L water capacity, totaling 12 units. Each treatment jar was labeled with a code. Before use, the jars were soaked in a bleach solution and then scrubbed as well as rinsed with a sponge. Afterward, they were dried for 24 hours. The water used for rearing the larvae was pre-settled in a tank.

The research used wild betta *Betta channoides* larvae, five days old, with 120 individuals. The larvae were sourced from Aldi Farm in Depok, West Java. The average length of the larvae was 0.2±0.00 cm, with an average weight of 0.03±0.04 g (Figure 2). The stocking density for each treatment was ten fish per jar, with a water volume of 2.5 L. According to SNI standards (7735:2018), the optimal stocking density for betta fish larvae is four fish per liter. Water quality during rearing was maintained at a temperature of 26-28 °C, with a pH of 6.0-7.2, dissolved oxygen levels of 6.2-6.8 mg L^{-1}, and ammonia at 0 mg L^{-1}. Water changes and flushing were performed every week. Feeding was conducted three times a day to ad libitum for 60 days.

2.2 Sampling and Parameters

This research involved sampling every seven days using a scoop. The fish larvae were transferred into jars for observation, where their length and weight were measured. The larvae's length was measured with a ruler, and their weight was determined using a digital scale (Sari, 2022). Water quality parameters, including temperature, dissolved oxygen levels, and pH, were monitored regularly at 07:00 am and 04:00 pm (Nugroho *et al.,* 2016). This monitoring was crucial to ensure that the rearing environment remained conducive to the growth and health of the fish larvae. The parameters were calculated using the following formulas:

ALG (cm) = final lenght (cm) - initial lenght (cm)

AWG (g) = final weight (g) - initial weight (g)

$$\text{SLGR } (\%\ \text{day}^{-1}) = \sqrt[\text{time}]{\frac{\text{final lenght}}{\text{initial lenght}}} - 1 \times 100$$

$$\text{SLGR } (\%\ \text{day}^{-1}) = \sqrt[\text{time}]{\frac{\text{final weight}}{\text{initial weight}}} - 1 \times 100$$

SR (%) = number of initial fish / number of final fish x 100

2.2 Statistic Analysis

Data were analysed using SPSS with Duncan's test and the Kruskal-Wallis test with 95% confidence level.

III. RESULT

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Table 1. Performance of absolute length growth, absolute weight growth, specific growth rate and survival rate of wild betta *Betta channoides* larvae

Parameters	Treatments			
	CD	CS	KA	Control
ALG (cm)	0.466±0.057[a]	0.780±0.020[c]	0.606±0.011[b]	0.560±0.000[b]
AWG (g)	0.014±0.000[a]	0.027±0.000[d]	0.021±0.000[c]	0.018±0.000[b]
SLGR (% days^{-1})	0.039±0.025[a]	0.050±0.000[b]	0.050±0.000[b]	0.039±0.025[a]
SWGR (% days^{-1})	2.00±0.000[a]	11.00±0.000[c]	6.50±0.000[b]	6.50±0.,000[b]
SR (%)	6.666±5.773[a]	93.333±5.773[c]	70.00±17.321[b]	76.66±5.773[b]

Note: Different superscript letters on the same line show a significant difference value (P<0.05). CD (Feeding with bloodworms), CS (Feeding with silk worms), KA (Feeding with water fleas), and Control (Feeding with Artemia). ALG (absolute lenght growth), AWG (absolute weight growth), SLGR (specific lenght growth rate), SWGR (specific weight growth rate), and SR (survival rate).

The highest percentages for absolute length growth rate, absolute weight growth rate, and survival rate were observed in the treatment with silkworms (CS). The lowest percentages for each parameter were found in the treatment using bloodworms (CD). The observation data for absolute length growth rate, absolute weight growth rate, and survival rate for each treatment are presented in Table 1.

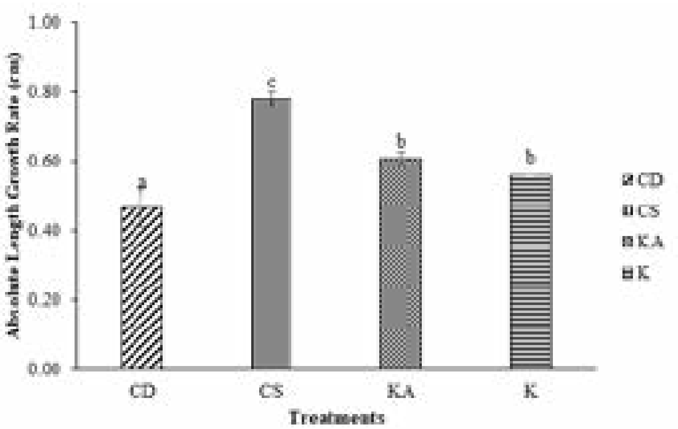

Figure 3. The average absolute length growth rate of wild betta *Betta channoides* larvae

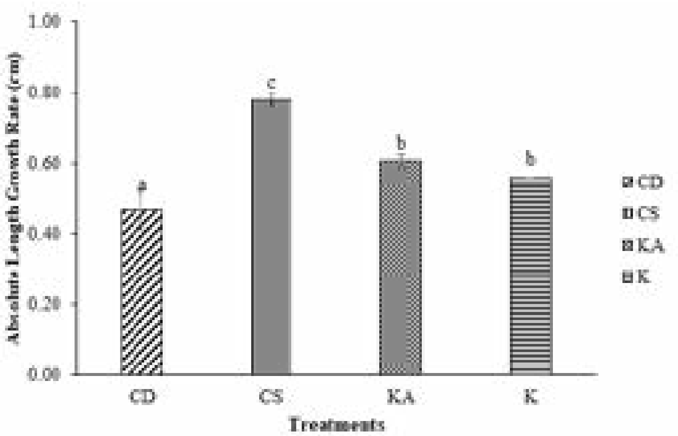

Figure 4. The average absolute weight growth rate of wild betta *Betta channoides* larvae

Observations of the absolute length growth rate of wild betta larvae revealed that the CS treatment was approximately 0.780±0.020, significantly (P<0.05) higher than the other treatments. The KA treatment, with a value of around 0.606±0.011, and the Control, with a value of approximately 0.560±0.000, showed no significant differences (P>0.05). In contrast, the CD treatment, with a value of around 0.466±0.057, and the KA treatment, at approximately 0.606±0.011, exhibited significant differences (P<0.05). The absolute length growth rate data for wild Betta larvae in each treatment is displayed in Figure 3.

Based on observation data of the absolute weight growth rate of wild betta *Betta channoides* larvae, the CS treatment had a value of approximately 0.780±0.020 significantly different (P<0.05) from the other treatments. The CD treatment had a value of around 0.014±0.000, the KA treatment was around 0.021±0.000, and the control had a value of approximately 0.018±0.000 (P<0.05). Observation data on the absolute weight growth rate of wild betta fish larvae for each treatment is presented in Figure 4.

The calculated data for the specific length growth rate of wild betta *Betta channoides* larvae, showed that the highest values were observed in the CS and KA treatments, both at 0.050±0.000. In contrast, the CD treatment and control treatment had values of 0.039±0.025. These results showed that the CS and KA treatments had a significant effect compared to the CD and control treatments (P<0.05). Observation data on the specific length growth rate of wild betta fish larvae for each treatment is presented in Figure 5.

The results from the specific weight growth rate

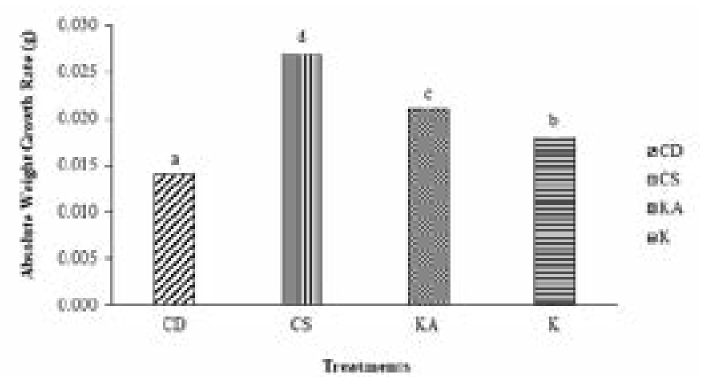

Figure 5 Specific length growth rate of wild betta fish *Betta channoides* larvae

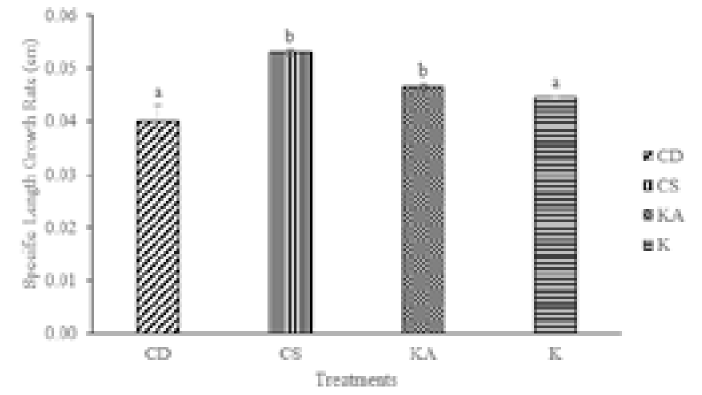

Figure 6 Specific weight growth rate of the wild betta fish *Betta channoides* larvae

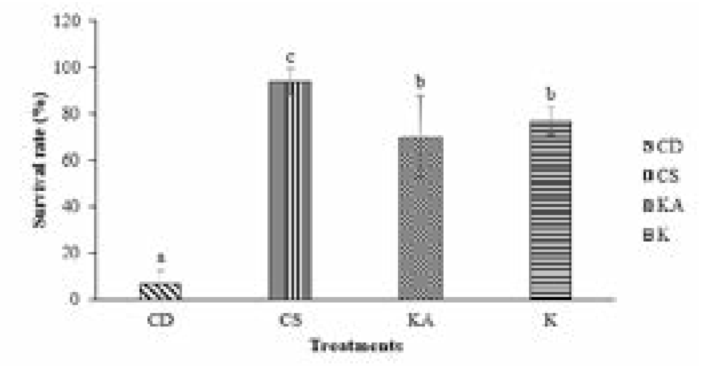

Figure 7 Survival rate of the wild betta fish *Betta channoides* larvae

calculations indicate that the highest value occurred in the CS treatment, at 11.00±0.000. This was followed by the KA and Control treatments, with values of 6.50±0.000, and the CD treatment at 2.00±0.000. These findings suggest that the CS treatment had a significant effect compared to the other treatments (p<0.05). The specific weight growth rates of wild betta fish larvae across all treatments are illustrated in Figure 6.

Observation data on the survival rate of wild betta larvae showed that the CS treatment reached approximately 93.33±5.773 %, significantly different from all other treatments. The KA treatment, with a value of around 70.00±17.321 %, and the control group, at 76.66±5.773%, did not show a significant difference (p>0.05). In contrast at 6.666±5.773 %, the CD treatment showed a significant difference compared to the KA treatment 70.00±17.321 % (p<0.05). The survival rate data for wild betta larvae in each treatment are illustrated in Figure 7.

Water quality parameters monitored include temperature and pH, which were measured at 08:00 am and 16:00 pm. The data from these measurements are presented in Table 2.

IV. DISCUSION

Wild betta fish are classified as a species threatened with extinction. They are also rarely cultivated, as they have only recently been domesticated, contributing to their relatively high market price. Cultivation of this fish requires solutions to enhance and accelerate growth, thereby shortening the cultivation period. One practical approach is to provide high-quality feed, which is crucial for maximizing cultivation outcomes (Sartika *et al*., 2019).

Spawning of wild betta fish is typically conducted with a sex ratio of 1:1 or in pairs (Permana *et al*., 2021). Fasya (2022) mentioned that the male of betta fish was ready to spawn, weighed between 6-8 g and measure 4-5 cm in length, while females were selected based on the maturity of their gonads, indicated by a whitish coloration on their bellies. Spawning occurs in an aquarium measuring 40 × 25 × 20 cm, with a water volume of 15 L. The aquarium is equipped with shelter media, such as pieces of foam and three ketapang leaves, to mimic their natural habitat, which tends to have slightly acidic water (Basir & Kaharuddin, 2020).

Observations are conducted daily during spawning to monitor when the wild betta fish begin to mate. The mating process resembles that of ornamental wild betta fish, forming a circular pattern (Lichak *et al*., 2022). However, a unique aspect of these fish is their incubation of eggs and larvae in their mouths, classifying them as mouthbrooders (Sinha & Pandey, 2023).

The incubation period is established once mating is observed, ensuring that the timing for harvesting the larvae. Larvae harvesting occurs on the eighth day after the wild betta fish spawn. This process involves gently shaking the mouth of the male betta fish by opening its mouth underwater until all the larvae are released. Each

Table 2. Water quality wild betta *Betta channoides* larvae

Parameters	Treatments				Quality standards (SNI 7735:2018)
	CD	CS	KA	Control	
Suhu (°C)	26.3–27.9	26.3–27.9	26.3–27.9	25.8–27.9	24.0–27.0
pH	6.7–7.1	6.2–7.2	6.0–7.2	6.0–7.2	6.0–7.0

Note: CD (Feeding with bloodworms), CS (Feeding with silk worms), KA (Feeding with water fleas), and Control (Feeding with Artemia).

spawning typically produces 30-40 larvae (Permana *et al*., 2024). Natural feeding is initiated five days post-harvest or once the yolk sac has been fully absorbed. During the larval phase, an adequate supply of protein is essential to support growth until the fish reach adulthood.

Feeding silkworms is the most effective method for increasing the absolute weight gain of wild betta fish larvae, yielding a value of 0.027 ± 0.000 g and an absolute length growth of 0.780 ± 0.020 cm. These results align with research by Armando (2018), which indicates that silkworms significantly enhance the growth performance of wild betta fish compared to alternative feeds such as water fleas. This effectiveness is attributed to the fact that silkworms are easier for fish to digest, thereby promoting body growth and development. Nugroho *et al.* (2015) note that silkworms have a segmented body and lack an internal skeleton, making them highly digestible for fish.

In contrast, feeds like brine shrimp and water fleas contain digestive enzymes that act as catalysts, triggering autocatalytic processes (Dartnell, 2012). Feed quality significantly affects fish growth; therefore, providing a diet rich in nutrients that meets the fish's needs is crucial for achieving optimal long-term growth. Additionally, fat is essential for promoting length growth in fish, alongside protein (Tarigan, 2014).

The survival rate of fish in aquaculture is a critical parameter that determines the overall success of the operation. Monticini (2010) states that various factors, including seed quality, feed management, disease control, and water quality management, can influence the percentage of fish that survive to the harvest stage. The highest survival rate was observed in the silkworm treatment, at 93.33±5.773 %, while the lowest was recorded in the blodworm treatment, at 6.666±5.773 %. The low survival rate in the bloodworm treatment appears to be related to the increased turbidity of the rearing container compared to the other treatments. This turbidity is likely due to blood from the bloodworm contaminating the water during the enumeration process. This blood contains essential nutrients, so when these nutrients are released into the rearing medium, the larvae are left with only the shells of the bloodworm, which have diminished or depleted nutritional value (Huey *et al*., 2017). As a result, the larvae may suffer from nutritional deficiencies, ultimately leading to mortality. According to Fauziah (2021), turbid water can hinder the development of betta fish. It may even pose a risk of death, making it essential to monitor the turbidity levels in the aquarium regularly. Excessively high or low turbidity can reduce appetite, induce fatigue, and decrease activity levels in fish. When exposed to murky water containing fine particles, fish are particularly vulerable to adverse effects. Increased water turbidity can also decrease the survival rate of fish egg embryos (Harahap & Sari, 2023).

An optimal aquatic environment is crucial for the health and survival of fish, as water quality must be clean and free from harmful contaminants. According to Simbeye & Yang (2014) key parameters such as pH, temperature, dissolved oxygen, and ammonia levels must be monitored regularly. Sudden changes in water quality can weaken the immune system, induce stress, and increase the risk of disease (Agustini *et al*., 2022).

The results of water quality measurements during the rearing of wild betta fish with different feeds indicating that the conditions met the standards for rearing these fish. The recorded temperature range during the natural rearing of wild betta fish varied from 25.8 to 27.9 °C, while pH values ranged from 6.0 to 7.2. This range is considered optimal, aligning with the SNI 7735 (2018) guidelines, which recommend a temperature of 24.0–27.0 °C and a pH between 6.0 and 7.0 for rearing *Betta channoides* (Permana *et al*., 2024)

Environmental temperature plays a significant role in egg metabolism; higher temperatures can enhance dissolved oxygen levels and affect pH, while lower temperatures may decrease dissolved oxygen and accelerate fish metabolism (Permana *et al*., 2021). Maintaining an optimal temperature supports the stability of fish metabolism, thereby promoting growth and health. Abi (2020) noted that pH levels that are too low or too high can lead to lethargy and potentially result in mortality for wild betta fish. Effective environmental management, including regular monitoring of temperature and pH, is essential for the optimal growth and health of *Betta channoides*.

V. CONCLUSION

Providing different feeds significantly impacts on growth performance and survival rate (SR). The highest growth performance and SR were observed in the silkworm (CS) treatment. The nutritional profile of silkworms is considered optimal for feeding betta fish larvae, as they contain the highest protein content 57% protein, 2.04% crude fiber, 13.3% fat, and 3.6% ash.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript.

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AUTHORS' CONTRIBUTION

All authors have contributed to the final manuscript. . Each author's contribution is listed below: Author's Contribution All authors have contributed to the final manuscript. The contribution of each author is as follows, Andri Iskandar (AIS); devised the main conceptual ideas, drafted the manuscript and critical revision of the article, Wahyu Dwi Setiawan (WDS); technical implementation in the field, drafted the manuscript and revision of article, Asep Permana (ASP); technical implementation in the field, drafted the manuscript and revision of article, Cecilia Eny Indriastuti (CEI) searched the related topic and collected data.

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