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The Effect of Different Natural Feeds on the Color Brightness of Ornamental Betta Fish (*Betta splendens*)

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ABSTRACT

Betta fish (*Betta* sp.) is one of the highly popular ornamental fish, with their market value and desirability significantly influenced by the brightness of their coloration and their survival rate. One way to increase the brightness and survival rate of betta fish is to provide natural feed containing carotenoids. This study aims to investigate the effect of various natural feeds on the color brightness of betta fish. The method used in this study was an experimental design with complete randomization, consisting of 4 treatments and 5 replications. The feed used for incomparison of this study was the type often used by betta fish breeders: (A) commercial pellets, (B) silkworms (*Tubifex* sp.), (C) bloodworms (*Chironomus* sp.), and water fleas (*Moina* sp.). Overall, the research confirmed that natural feeds significantly improve betta fish color brightness compared to commercial feed. This study showed that the group given water fleas had the fastest and most striking colors in weeks 2 to 6, with the brightness value decreasing from 79±2.2° in the first week to 29±2.9° in the sixth week. However, in the seventh week, silkworms had a better contribution than the other treatment with a final degree value of 19±3.8°. Regarding survival rates, there was no significant difference among the natural feed groups, with the commercial pellet treatment showing the lowest survival. Bloodworms as natural feed for betta fish are recommended to increase the brightness of the color (19±3.8°) and survival rate (93±15%) of the betta fish. Unfortunately, the exact carotenoid content of each natural food was not measured in this study. Further research is needed to isolate carotenoids from their sources and test them on betta fish to evaluate the color and other growth parameters.

INTRODUCTION

Betta fish (*Betta* sp.) are incredibly popular ornamental fish, highly sought after for their stunning colors, intricate patterns, elegant fins, and unique shapes **(Lichak *et al.*, 2022)**. In addition, betta fish also have a high price, with breeding pairs valued at 10–16 USD **(Nur *et al.*, 2022)**. The value of ornamental fish is determined by many factors, and one of the most important is color. Vibrant color serves as a key indicator of aesthetic appeal in ornamental fish; brighter hues directly correlate with increased attractiveness and higher market prices **(Lichak *et al.*, 2022)**. Consequently, maintaining and enhancing the color quality of betta fish is crucial for betta fish breeders. However, achieving superior color quality in betta fish presents challenges, as breeders frequently encounter issues such as pale or dull coloration **(Kristiana *et al.*, 2022)**. These chromatic variations often stem from changes in pigment levels. According to **Sathyaruban *et al.* (2021)**, aquatic animals like betta fish cannot synthesize carotenoids—the pigments responsible for body coloration—and must therefore acquire these through their diet.

One method used to enhance the color quality of betta fish is through feed supplementation with carotenoids. The addition of color-enhancing sources in feed, such as carotenoids, promotes an increase in the fish's body pigments, thereby maintaining and even intensifying their coloration **(Sathyaruban *et al.*, 2021)**. Carotenoids are a group of natural pigments that play an important role in providing the yellow, orange, and red colors of organisms, including fish **(Sathyaruban *et al.*, 2021)**. The efficacy of carotenoids in enhancing fish coloration has been demonstrated in prior research on species such as koi and goldfish **(Khieokhajonkhet *et al.*, 2022; Liu *et al.*, 2024)**. These carotenoids are found in several natural foods such as silk worms (*Tubifex* sp.), bloodworms (*Chironomus* sp.), and water fleas (*Moina* sp.). Previous studies stated that the carotenoid content of *Tubifex* reached 8000 ppm in the live form and 700 ppm in dry form **(Nurjihan *et al.*, 2024)**. A study of *Chironomus* revealed its carotenoid content is 104.17 µmol/L **(Lumbessy *et al.*, 2024)**, while a study of *Moina* showed carotenoid content of 29.5 ± 2.50 µg/g dry wt. mass **(Velu *et al.*, 2003)**.

These three natural foods have sufficient carotenoids and have been used to improve the color of ornamental fish such as glofish **(Dewi *et al.*, 2025)**. This study was conducted with the aim of evaluating the effect of providing different natural feeds on the brightness of betta fish coloration.

MATERIALS AND METHODS

1. Experimental design

The fish used in this study were 2-month-old multicolored betta fish (*Betta* sp.) with an initial length of 2.5 cm and an initial weight of 0.65 g. A total of 60 fish were obtained from betta fish breeders (Bluerim Surabaya, Wiyung, Surabaya, Indonesia) and maintained for two months. This study involved four treatments—silk worms, bloodworms, water fleas, and a control—and five replications per treatment. The feed types evaluated in this study were those commonly used by betta fish breeders: silk worms (*Tubifex* sp.), bloodworms (*Chironomus* sp.), and water fleas (*Moina* sp.), all purchased from the Gunung Sari ornamental fish market, Surabaya (Indonesia). The treatment groups were as follows: (A) commercial pellets (control), (B) silk worms, (C) bloodworms, and (D) water fleas.

The maintenance containers consisted of 20 clear glass jars (30 cm height × 18 cm diameter), each with a volume of 4 L. These containers were cleaned, dried, and filled with 3 liters of settled water that had been conditioned for 24 hours. Once the containers were prepared, the 60 juvenile betta fish were distributed into the jars, with three fish per jar following an acclimatization period.

Fish were treated for two months and fed twice daily—at 10:00 WIB and 16:00 WIB (Waktu Indonesia Barat/Western Indonesia Time/GMT+7). The feed dosage was set at 4% of body weight per day, as the optimal feeding rate for fish generally ranges from 3–5% of body weight daily **(Kumkhong *et al.*, 2024)**. Water changes were conducted every two days by replacing 10% of the water to reduce ammonia levels resulting from leftover feed **(Iqbal *et al.*, 2023)**. After each water change, one *ketapang* leaf (*Terminalia catappa*) was added to help maintain water quality by lowering pH **(Kajimura *et al.*, 2023; Melanisia *et al.*, 2023)**.

3. Data analysis

Data analysis was conducted using SPSS version 25.0, employing a Completely Randomized Design (CRD). Observations were carried out over a two-month (seven-week) period, during which data were collected on both color brightness and survival rate. Color measurements involved transferring the fish to a specialized photo aquarium **(Kiswara *et al.*, 2020)**. The aquarium was placed on a flat surface with a yellow background under consistent lighting conditions in a closed room, using only lamps as the light source.

Weekly hue value measurements were taken throughout the experiment. Images were captured and processed using Adobe Photoshop, with the tail fin selected as the focal point for hue analysis. This was due to the tail fin's higher concentration of color pigments, making it a reliable indicator of feed-induced changes in coloration **(Wei *et al.*, 2019; Kiswara *et al.*, 2020)**. Hue is measured as an angular value (0°–360°) on the color wheel that defines the base color **(Parajuli *et al.*, 2024)**. For example, smaller hue values indicate brighter colors, with 0° representing red, 120° representing green, and 240° representing blue **(Simbolon *et al.*, 2022)**. Thus, a lower hue value corresponds to greater brightness.

Survival rate data were calculated using the formula provided by **Fauziyyah *et al.* (2025)**:

$$SR = \frac{Nt}{\text{No}} \times 100$$

Note:
SR = *Survival Rate* (%)
Nt = Number of fish at the end of the study (fish)
No = Number of fish at the start of maintenance (fish)

RESULTS

1. Betta fish color brightness

Table 1. The brightness of the color of betta fish with different feeding

Week	A	B	C	D
1	75±3.5^{a}	81±2.5^{b}	79±2.3^{b}	79±2.2^{b}
2	70±3.4^{b}	72±2.5^{c}	75±2.3^{d}	63±3.2^{a}
3	62±3.4^{b}	62±2.3^{b}	72±2.1^{c}	53±2.6^{a}
4	57±3.4^{c}	52±3.6^{b}	62±1.9^{d}	42±2.0^{a}
5	50±3.7^{c}	40±2.9^{b}	49±1.8^{c}	34±3.1^{a}
6	46±2.5^{c}	30±3.4^{a}	34±2.1^{b}	29±2.9^{a}
7	40±2.4^{d}	19±3.8^{a}	22±2.0^{b}	25±2.8^{c}

Note: A = Commercial pellet, B = Silk worm/*Tubifex* sp., C = Blood worm/*Chironomus* sp., D = Water fleas/*Moina* sp. Different superscripts on the same line indicated significant differences. (P<0.05).

The color brightness of betta fish over the seven-week study period is presented in Table (1). In the first week, the control group fed with commercial pellets exhibited a significantly different hue value (75 ± 3.5°) compared to the other feeds. However, no significant differences were observed among the test feed treatments at this stage. By the second week, all treatment groups showed significant differences in hue values. The group fed with water fleas (*Moina* sp.) had the lowest hue value (63 ± 3.2°), indicating the brightest coloration, as lower hue values correspond to greater color brightness.

This trend persisted through weeks 3 to 6, with the *Moina* sp. group consistently demonstrating significantly lower hue values compared to the other treatment groups, including the control. However, in the seventh week, the silk worms (*Tubifex* sp.) group achieved the lowest hue value (19 ± 3.8°), followed by bloodworms (*Chironomus* sp.) at 22 ± 2.0°, *Moina* sp. at 25 ± 2.8°, and the control at 40 ± 2.4°. All test feed groups showed statistically significant differences during this final week.

These results indicate that while *Moina* sp. contributed to brighter coloration earlier in the trial, silk worms ultimately produced the most intense color brightness by the seventh week. The final coloration of the fish at week seven is shown in Fig. (1).

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Fig. 1. Fish body color in the 7th week of the study. Control (Left-Top); Silkworm/*Tubifex* sp. (Right-Top); Bloodworm/*Chironomus* sp. (Left-Bottom); Water Flea/*Moina* sp. (Right-Bottom)

2. Survival rate

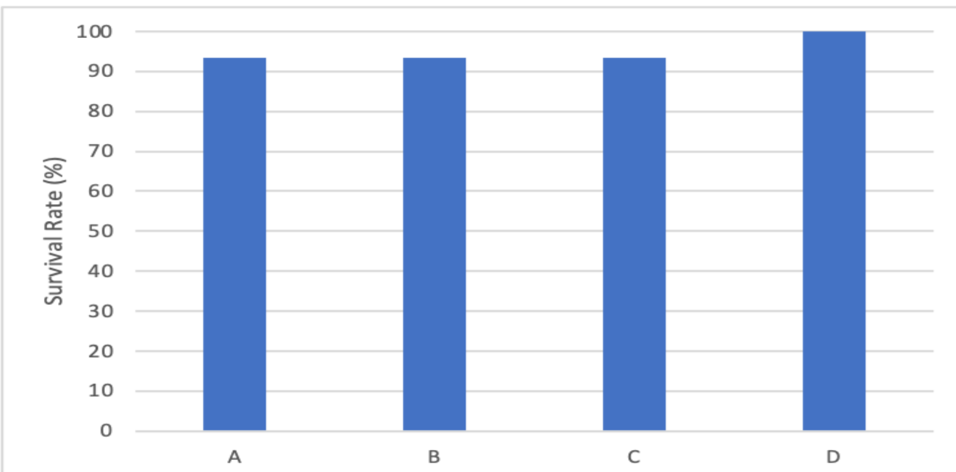

Fig. 2. Survival rate of betta fish with different feeds

Note : A = Commercial pellet, B = Silk worm/Tubifex sp., C = Blood worm/Chironomus sp., D = Water fleas/*Moina* sp.

The survival rate of betta fish over the seven-week study period is presented in Fig. (2). As shown in the figure, the survival rate was generally higher in groups that received adequate nutrition and were maintained in a suitable environment. The recorded survival rates ranged from 93% to 100%. Feeding with silk worms, bloodworms, *Moina* sp., and commercial pellets (control) showed no statistically significant differences in survival rate. Although the lowest survival rates were observed in the live feed treatment groups, the variation was minimal and not significant.

DISCUSSION

This study demonstrates that the type of feed provided has a significant effect on the color brightness of betta fish. Over the seven-week observation period, fish fed natural silkworms (*Tubifex* sp.) showed a more substantial increase in color brightness by the seventh week compared to those fed artificial pellets, bloodworms (*Chironomus* sp.), or water fleas (*Moina* sp.). Although the bloodworm treatment produced the highest brightness from weeks 2 to 6, silkworms ultimately yielded the brightest coloration in week 7. This suggests that the nutritional content of silkworms is highly effective in stimulating pigment formation in betta fish.

Silkworms contain carotenoid pigments, particularly astaxanthin, at concentrations up to 8,000 ppm in live form, which significantly enhances the coloration of ornamental fish **(Nurjihan *et al.*, 2024)**. In comparison, *Chironomus* has a carotenoid content of 104.17 µmol/L **(Lumbessy *et al.*, 2024)**, while *Moina* contains 29.5 ± 2.50 µg/g dry weight **(Velu *et al.*, 2003)**. Carotenoids are the primary compounds responsible for triggering pigmentation in ornamental fish, and they must be obtained through natural feeds such as silkworms, bloodworms, and water fleas, as they are not present in artificial pellets **(Li & Liu, 2021; Ayuningsih *et al.*, 2024; Nurjihan *et al.*, 2024)**. The effectiveness of silkworms in enhancing fish coloration has also been demonstrated in studies involving guppies (*Poecilia reticulata*) and clown loaches (*Chromobotia macracanthus*) **(Andriani *et al.*, 2020; Nurjihan *et al.*, 2024)**.

Overall, this study confirms that natural feeds significantly enhance betta fish coloration more effectively than commercial feeds. This aligns with the findings of **Sathyaruban *et al.* (2021)**, who stated that carotenoids—crucial for pigment development in fish—cannot be synthesized internally and must be sourced through the diet.

The survival rates observed with natural feeds in this study ranged from 93% to 100%, aligning with **NengTias *et al.* (2021)**, who noted that survival rates between 87% and 100% are considered good in betta fish cultivation. The use of silkworms, bloodworms, and water fleas had no significant impact on survival, likely due to their high protein content: silkworms at 57%, bloodworms at 62.5%, and water fleas at 55.4–68.1% **(Dwiardani *et al.*, 2020; Hasan *et al.*, 2023; Lumbessy *et al.*, 2024)**. Protein supplies essential amino acids necessary for muscle and tissue development, thereby supporting fish growth **(Ryu *et al.*, 2021; AbouelFadl *et al.*, 2024)**. It also plays a key role in tissue repair, immune response, and metabolic processes **(Li *et al.*, 2021; Ryu *et al.*, 2021)**, contributing to higher survival rates by keeping fish healthy and resilient. Additionally, the natural feed used was appropriately sized for the mouth opening of betta fish, facilitating efficient consumption and utilization **(Iqbal *et al.*, 2023)**.

Protein is the most crucial nutrient in fish feed, essential for the formation of muscles, skin, fins, and internal organs **(Nemova *et al.*, 2021; Siddik *et al.*, 2021)**. Interestingly, commercial feed resulted in the lowest survival rate ($86 \pm 19\%$), likely due to its comparatively lower nutrient quality when fed to betta fish **(Iqbal *et al.*, 2023)**. Prior studies have shown that betta fish fed commercial feed exhibited significantly lower growth performance (0.10 ± 0.03 g; 0.57 ± 0.1 cm) compared to those given natural feed (0.52 ± 0.02 g; 1.33 ± 0.053 cm) **(NengTias *et al.*, 2021)**. This may be due to the betta fish's more efficient digestion of natural feed, which allows for better nutrient absorption **(NengTias *et al.*, 2021)**. As carnivorous fish, bettas are naturally better suited to digesting fresh animal protein. In contrast to live feeds, commercial pellets are non-moving and do not trigger the fish's hunting instincts, reducing feeding motivation **(Saputra *et al.*, 2024)**.

CONCLUSION

The results of this study show that different types of natural feed significantly affect the color brightness of betta fish. Among the tested feeds, bloodworms proved to be the most effective in enhancing both color brightness and survival rate during the earlier stages of the study. Therefore, the use of bloodworms (*Chironomus* sp.) is recommended as a natural feed option to improve the visual appeal and viability of betta fish. However, this study did not include direct measurement of the carotenoid content in each natural feed type. Future research is needed to isolate and quantify the specific carotenoids present in these feed sources and to evaluate their effects not only on color enhancement but also on other important growth parameters in betta fish.

ETHICS STATEMENT

No animals or fish were harmed or improperly treated during this study.

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