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THE EFFECT OF ASTAXANTHIN ADDITION IN ARTIFICIAL FEED ON INCREASING THE COLOR BRIGHTNESS OF SNAKEHEAD FISH (*Channa maruliodes*)

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ABSTRACT

Snakehead fish (*Channa maruliodes*) is a freshwater fish that is increasingly popular among ornamental fish enthusiasts, especially because of its beautiful colors. Color brightness is an important factor in the culture of snakehead fish. This study aims to evaluate the effect of astaxanthin addition on increasing the color brightness of snakehead fish. This study used a completely randomized design (CRD) experimental method consisting of 4 treatments with five replications. The treatment used was the addition of Astaxanthin (AST) with doses of 0% (AST0), 1% (AST1), 3% (AST3), and 5% (AST5). The snakehead fish used had a weight size between 30.4-30.8 g/individual. The parameters measured in this study were the increase in color brightness, growth, feed conversion and efficiency, and the quality of the maintenance media. The results showed that the addition of astaxanthin in the feed significantly affected the level of color brightness, growth, and feed utilization of snakehead fish (P <0.05). The best addition of astaxanthin was obtained in the AST5 treatment with a TCF value of 5.17, total carotenoids (136.68 ppm), absolute weight (23.00 g), absolute length (3.10 cm), specific growth rate (78.00%), feed conversion (4.35), and feed efficiency of 23.00%. These findings indicate the potential of astaxanthin in improving the quality of catfish culture.

Keywords: Astaxanthin, *Channa maruliodes*, Color brightness

1. INTRODUCTION

Snakehead fish (*Channa maruliodes* F. Hamilton, 1822) is a local fish species as a common consumption fish but has now changed into an ornamental fish in great demand because of its beautiful colors. This fish is a native species in Riau province and is spread in the Kampar River waters. The beauty of its colors has attracted the attention of ornamental fish lovers, both from within the country and abroad.

According to data from the Ministry of Marine Affairs and Fisheries, especially from the Pekanbaru Fish Quarantine, Quality Control and Safety of Fishery Products, the number of jalai fish shipments from Riau to all over Indonesia in 2023 is 4,765 fish, with a total value of around IDR 590,225,000/year. This shows the great potential of jalai fish if cultivated to the maximum.

The main interest in ornamental fish lies in the brightness of the color; the more striking the color of the fish is, the higher its value. One of the fish as an ornamental fish is the Jalai fish. Therefore, it is vital to improve and maintain the quality of the color so that the fish remain attractive and have optimal value. The advantage of ornamental fish lies in the brightness of the color of their bodies[1]. Fish color is caused by pigment cells (chromatophores) or macroscopically found in the dermis on fish scales[2]. Chromatophores can be classified into five basic color categories, namely black (melanophores), yellow (xanthophores), red or orange (erythrophores), shiny reflection

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cells (iridophores), and white (leukophores)[3].

Astaxanthin, a compound in the carotenoid pigment group, can be used as a feed additive to increase the brightness of the color in ornamental fish. Carotenoids are natural components that form color pigments that have a reasonably good effect on red and yellow colors[4]. Carotenoids come from animals and plants and have various types, including β-carotene, lutein, taraxanthin, astaxanthin, and zeaxanthin[5].

Jalai has a beautiful color; during its life, it experiences three color phases, namely when it is still a dark bluish seed; in the second phase, it is brown with a white belly, almost similar to the common snakehead fish, in the third phase the jalai begins to show a yellowish/orange color and when it is an adult it will grow a black pattern with white edges on its scales (flowers), namely when the jalai fish enters the age of 1.5 years, and the pattern will increase with age[6]. However, this natural process is sometimes too long to wait, while the demand for jalai fish is very high in the ornamental fish market. Therefore, fish breeders try to accelerate the emergence of this beautiful color in various ways. Efforts can be made to achieve bright and even colors in fish by applying pigment manipulation techniques. This technique involves increasing the content of pigment cells in the fish's body by providing feed containing carotenoids (Astaxanthin)[7].

However, the effectiveness of astaxanthin administration in enhancing color in Jalai is not yet known. Previous studies have shown that the addition of astaxanthin to feed can increase color brightness in several fish species, including goldfish research conducted by Sitorus et al.[7]; clownfish (*Amphiprion percula*)[8]; koi carp (*Cyprinus carpio*)[9].

Based on this, research needs to be conducted to determine the effect of providing feed containing astaxanthin at different doses to increase color brightness in jalai (*Channa maruliodes*).

2. RESEARCH METHOD

Methods

The feed used was commercial feed with a protein content of 39%, which was then added with astaxanthin flour according to the dose in each treatment, namely, the first treatment (AST0) 100% commercial feed without the addition of astaxanthin as a control. The second treatment (AST1) was the provision of 1% astaxanthin in the feed; in 100 g of feed, 1 g of astaxanthin was added. The third treatment (AST3) was the provision of 3% astaxanthin in the feed; in 100 g of feed, 3 g of astaxanthin was added. The fourth treatment (AST5) was the provision of 5% astaxanthin in the feed; in 100 g of feed, 5 g of astaxanthin was added. The stages of mixing astaxanthin in feed are first dissolved in water with a dose of 70 mL/100 g of feed. Commercial feed is crushed into granules and mixed with astaxanthin solution until it becomes a paste, then the feed is ready to be given to the test fish. Each aquarium contains one fish with an average weight of 30.6 g, an average length of 16.7 cm, and 30 L of water. Feed is given as much as 5% of body weight.

Jalai were kept for 50 days, and the fish were fed 3 times a day, namely at 08:00, 13:00, and 17:00 WIB. The feeding rate (FR) given was 5% of body weight10,11. Growth sampling, namely body weight and length, was performed every 10 days to determine the amount of feed to be given. To maintain water quality, water changes were carried out every 10 days, and changes were made as much as 50% of the amount of water in the aquarium, carried out in the morning before feeding. Water quality control was done by siphoning dirt at the aquarium's bottom every 5 days and then refilling the water using water that had gone through the aeration process. In this study, the water quality measured included water temperature, acidity level (pH), dissolved oxygen level (DO), and ammonia content.

The brightness level analysis was carried out using the Modified Toca Colour Finder (M-TCF) method (Figure 1), and the total carotenoid content in fish was measured using a UV-Vis spectrophotometer. The carotenoid analysis method was the jalai fish that had been corrected and killed, then the skin of the jalai fish was taken, dried, and weighed as much as 0.1 g, then 10 mL of technical acetone was added and homogenized using centrifugation at a speed of 1,500 rpm for one minute, after which it was filtered using Whatman 41 filter paper and the extract volume was measured. The absorbance was measured at 480, 645, and 663 nm wavelengths. The calculation of carotenoids is based on the formula used by Soleha et al.[12] as follows:

$$Karotenoid(\mu mol/g) = \frac{((A480 + 0{,}114 \times A663 - 0{,}638 \times A645) \times V \times 10^3)}{(112{,}5 \times 0{,}1 \times 10)}$$

Note: A480 = Absorbance at 480 nm wavelength; A663 = Absorbance at 663 nm wavelength; A645 = Absorbance at 645 nm wavelength; V = Extract volume (mL)

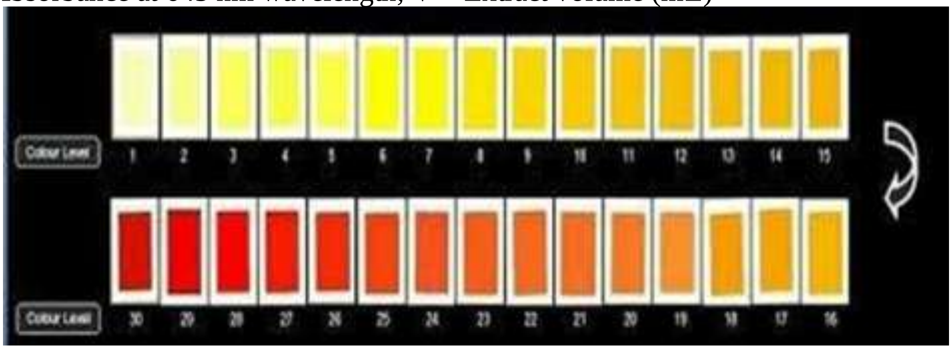

Figure 1. Modief Toca Colour Finder (M-TCF)

Data Analysis

Quantitative data on each treatment were analyzed using one-way Anova. Data are presented as mean ± std. Deviation was analyzed using SPSS version 25. If there is a significant difference (95%) between treatments, a further Duncan Multy Ranges test is carried out. Meanwhile, a descriptive analysis of water quality will be carried out.

3. RESULT AND DISCUSSION

The results showed that the addition of astaxanthin in the feed significantly affected the level of color brightness of Jalai fish ($p<0.05$). At the beginning of the culture, Jalai fish showed the lowest color brightness value (1 ± 0.00) with a carotenoid content of 98.22 ppm. However, after being given treatment with the addition of astaxanthin in the feed, there was a significant increase in color brightness (Table 1).

The analysis of color brightness showed that in the AST0 treatment, the color brightness level increased to 2.26 ± 0.23, while in AST1 and AST3, with values of 3.69±0.19 and 3.91±0.39, respectively. The highest increase was achieved in the AST5 treatment, which showed a color brightness of 5.17±0.43. These data indicate that the higher the dose of astaxanthin added to the feed, the brighter the color of the Jalai fish produced. The brightness of the color of the Jalai fish is presented in the following Figure 2.

The use of astaxanthin as a source of carotenoids in feed has been proven effective in increasing the brightness of the color of jalai, which is vital for the aesthetic and marketing value of the fish. These results provide essential contributions to fish farming practices and can be used as a basis for further research on the effects of nutrition on fish color.

Based on Table and Figure 1, it is known that adding astaxanthin to the feed of the jai fish is better than the control treatment (without the addition of astaxanthin). This is because the addition of astaxanthin can increase the carotenoid content in the body of the jai fish, thereby increasing the brightness of the color. Astaxanthin can form a reddish-orange pigment that increases the brightness of the color of the fish. Research shows that the correct dose of astaxanthin in feed can produce a more intense color in fish[8]; Sumatran fish (*Puntius tetrazona*)[13]; Clownfish (*Amphiprion ocellaris*)[14].

Table 1. The brightness level of color of the jalai fish after being given the treatment of adding astaxanthin to the feed at different doses.

Treatment	Color (M-TCF)	Karotenoid (ppm)
AST	1 ± 0,00	98,22 ± 16,35
AST0	2,26 ± 0,23[a]	115,70 ± 0,65[a]
AST1	3,69 ± 0,19[b]	128,18 ± 0,55[b]
AST3	3,91 ± 0,39[b]	131,99 ± 0,23[c]
AST5	5,17 ± 0,43[c]	136,68 ± 0,44[d]

Note: Different superscripts in the same column indicate significant differences between treatments (P<0.05).

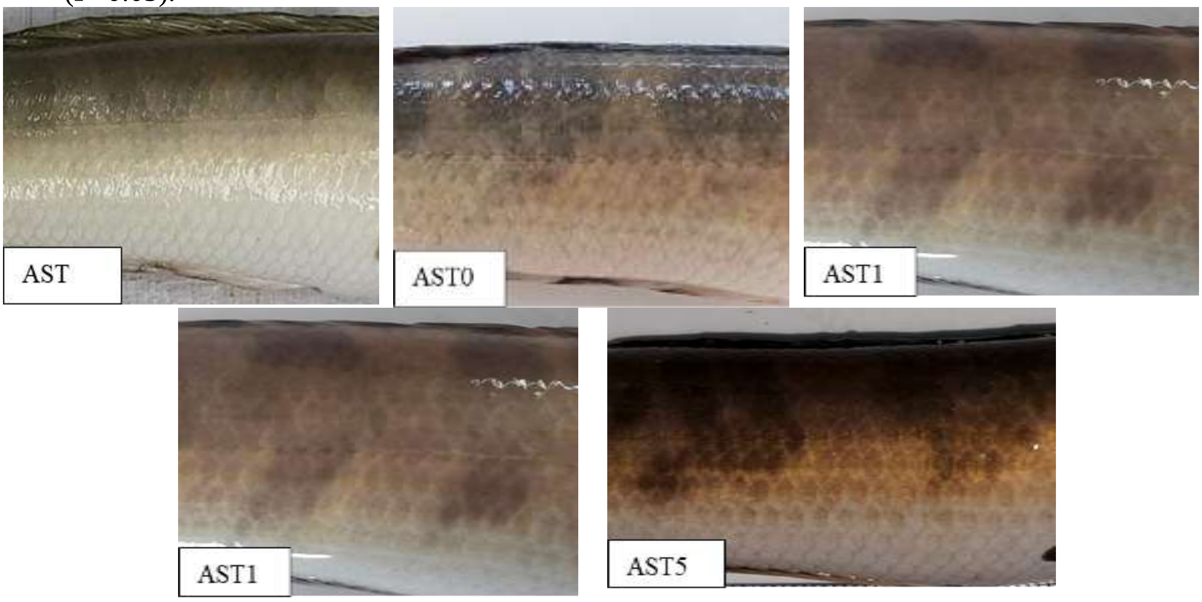

Figure 2. Brightness of the color of jalai (*Channa maruliodes*) in each treatment

Growth performance

The addition of astaxanthin in the feed significantly impacted the growth of Jalai ($p<0.05$). In the treatment without astaxanthin (AST0), the absolute weight obtained was 17.80±1.30 g, with absolute length growth and specific growth rate of 2.10±0.14 cm and 36.00±2.00%/day, respectively (Table 2).

The addition of an astaxanthin dose in AST1 treatment of 1% (Table 2) showed an average growth of absolute weight (PBM) of 21.60 ± 1.52 g, absolute length gain (PPM) of 2.84 ± 0.23 cm, and specific growth rate of 43.20 ± 3.03%/day. AST3 treatment (3%) also showed an increase, but not as significant as AST1, with PBM of 20.20± 1.30 g, PPM of 2.70±0.21 cm, and LPS of 40.80±2.28%/day. The most crucial growth occurred in the AST5 treatment, which showed the highest PBM of 23.00±0.71 g, PPM 3.10±0.22 cm, and LPS reaching 78.00±2.98%/day. This suggests that higher doses of astaxanthin in the feed correlate with better growth enhancement, likely due to the role of astaxanthin in improving fish metabolism and health.

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of 43.20±3.03%/day. AST3 treatment (3%) also showed an increase, but not as significant as AST1, with PBM of 20.20±1.30 g, PPM of 2.70±0.21 cm, and LPS of 40.80±2.28%/day. The most crucial growth occurred in the AST5 treatment, which showed the highest PBM of 23.00±0.71 g, PPM of 3.10±0.22 cm, and LPS reaching 78.00±2.98%/day. This suggests that higher doses of astaxanthin in the feed correlate with better growth enhancement, likely due to the role of astaxanthin in improving fish metabolism and health.

Table 2. Growth of Jalai fish for each treatment of astaxanthin addition in feed with different doses.

Perlakuan	B0 (g)	Bm (g)	Lm(cm)	LPS (%/day)
AST0	30,6 ± 0,55	17,80 ± 1,30^{a}	2,10 ± 0,14^{a}	36,00 ± 2,00^{a}
AST1	30,4 ± 0,55	21,60 ± 1,52^{b}	2,84 ± 0,23^{b}	43,20 ± 3,03^{b}
AST3	30,6 ± 0,55	20,20 ± 1,30^{bc}	2,70 ± 0,21^{bc}	40,80 ± 2,28^{b}
AST5	30,8 ± 0,45	23,00 ± 0,71^{c}	3,10 ± 0,22^{c}	78,00 ± 2,98^{c}

Description: Bm (Absolute weight growth), Lm (Absolute length growth), LPS (Specific growth rate). Different superscript letters in the same column indicate significant differences between treatments (P<0.05)

Table 2. This shows a significant increase in absolute weight growth and astaxanthin doses. The AST5 treatment with a dose of 5% showed the highest weight growth, which was 23.00±0.71 g, significantly different from other treatments (P <0.05). In contrast, the control treatment (AST0), which was not given astaxanthin, had the lowest growth (17.80±1.30 g). This shows that astaxanthin has a positive effect on weight gain in jalai. Giving carotenoids such as astaxanthin can increase fish metabolism and support better growth. Astaxanthin plays a vital role in improving the physical quality of fish, including fish weight growth[14]; clownfish[8]; comet fish[15]

The results of the analysis of absolute length growth showed that the addition of astaxanthin to the feed had a significant effect (P<0.05), wherein the AST5 treatment, the fish experienced the highest increase in length, which was 3.10 ± 0.22 cm, while the AST0 control group only showed an increase of 2.10±0.14 cm. This indicates that astaxanthin helps increase not only weight but also the length of the fish. Astaxanthin contributes positively to overall fish growth; the right dose of astaxanthin can improve the length and weight of fish simultaneously[14], swordtail platyfish, *Xiphophorus helleri*[16], and goldfish[17].

Feed Conversion and Efficiency

The results showed that the addition of astaxanthin in the feed significantly affected the conversion and efficiency of Jalai fish feed (p<0.05). In the treatment without adding astaxanthin (AST0), the feed conversion was recorded at 5.47 ± 0.36, with a feed efficiency of 19.16 ± 1.31%. An increase in feed efficiency was recorded in the AST1 treatment with better feed conversion, namely 4.48 ± 0.29 and feed efficiency reaching 22.40 ± 1.45% (Table 3).

Table 3. Average conversion and feed efficiency for each astaxanthin treatment in addition to feeding at different doses.

Treatment	FCR	EF (%)
AST0	5,47 ± 0,36^{b}	19,16 ± 1,31^{a}
AST1	4,48 ± 0,29^{a}	22,40 ± 1,45^{b}
AST3	4,74 ± 0,30^{a}	21,18 ± 1,36^{b}
AST5	4,35 ± 0,13^{a}	23,00 ± 0,69^{c}

Note: Different superscript letters in the same column indicate significant differences between treatments (P<0.05).

The analysis showed that the AST3 treatment showed a feed conversion of 4.74 ± 0.30, with a feed efficiency of 21.18 ± 1.36%. In contrast, the best treatment was seen in AST5, which had the lowest feed conversion (4.35 ± 0.13) and the highest feed efficiency (23.00 ± 0.69%). This indicates that the jalai can better utilize their feed with the addition of astaxanthin.

Table 3. shows that the treatment with the addition of astaxanthin at a dose of 5% (AST5) produced the highest feed efficiency of 23.00% and a feed conversion value of 4.35. In contrast, the control treatment (P0) showed the lowest feed efficiency of 19.16% and the highest feed conversion of 5.47. The addition of astaxanthin appears to affect the efficiency of feed utilization by jalai positively. With the right dose, feed efficiency can increase, which means less feed is needed to achieve the same growth, thus indicating an increase in feed conversion[15].

4. CONCLUSION

The addition of astaxanthin to the feed significantly affected the brightness of the color of jalai. The better brightness of the color of jalai fish was found in the addition of 5% astaxanthin flour with a carotenoid content of 136.68 ppm, (M-TCF) 5.17, (BM) 23.00 g, (LM) 3.10 cm. (LPS) 78.00%/day, (EPP) 23.00 and (FCR) 4.35.

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