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The Effect of Addition Red Dragon Fruit Skin Flour to Artificial Feed on The Enhancement of Color Brightness in Sumatra Fish (*Puntigrus tetrazona* (Bleeker, 1855))

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ABSTRACT

Color is a primary factor that makes fish highly desirable. The appearance of color is due to the presence of pigment cells or chromatophores within the fish's body. Feed significantly influences the enhancement of color brightness in fish. One essential component is the red dragon fruit skin flour, which serves as a natural source of carotenoids. This research aims to determine the impact of adding the optimum concentration of red dragon fruit skin flour in artificial feed to enhance the color brightness of Sumatra fish (Puntigrus tetrazona). The materials used during the study include Sumatra fish measuring 2-3 cm, red dragon fruit skin flour, CMC (Carboxymethylcellulose), specialized ornamental fish feed, and commercial feed. The experimental method employed a Completely Randomized Design with five treatments and three replications consisting of Treatment (A) Commercial feed without red dragon fruit skin flour (negative control), (B) Commercial feed with the addition of 12.5% red dragon fruit skin flour, (C) Commercial feed with the addition of 15% red dragon fruit skin flour, (D) Commercial feed with the addition of 17.5% red dragon fruit skin flour, (E) Commercial feed with improved color formula without using red dragon fruit skin flour (positive control). Color brightness observations were analyzed using the Kruskal-Wallis test, and if there was a significant difference, a post hoc test (Z-test) was performed. The research results showed that the enhancement of color in the head, dorsal fin, and tail fin of Sumatra fish on day 30 exhibited the highest values in the treatment with the addition of 15% red dragon fruit skin flour, with an average score of 0.31 for the head, 2.60 for the

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dorsal fin, and 1.31 for the tail fin. The optimum concentration for the addition of red dragon fruit skin flour for the best enhancement of color brightness was found to be 15%.

***Keywords*:** Sumatra Fish, Red Dragon Fruit Skin Flour, Color

1. INTRODUCTION

The ornamental fish sector has the potential to contribute to increasing income for the community. One of Indonesia's native fish is the Sumatra fish, which has high market opportunities and is highly favored by foreign ornamental fish enthusiasts [1]. The Sumatra fish (*Puntigrus tetrazona*) is a native Indonesian ornamental fish commonly found in the common waters of Sumatra and Kalimantan. The Sumatra fish has an elongated and laterally compressed body, small and flat in shape, with a short snout and a terminal mouth position [2]. The distinctive feature of the Sumatra fish is its reddish-yellow body color adorned with four vertical lines in blackish-green running across its body. The first line passes through the eye, the second line is located in front of the dorsal fin, the third line crosses the base of the anal fin, and the last line crosses the base of the tail fin [2]. Color is a primary factor that makes ornamental fish highly sought after by the community for pond and aquarium decoration. The emergence of color in fish is due to the presence of pigment cells or chromatophores found in the dermis, both outside and under the fish scales [3]. Fish cannot synthesize carotenoids on their own, so carotenoids need to be added to their diet. Feeding fish with pigmented or specific color-enhancing substances, such as carotene, can increase the pigment content in Sumatra fish, making their color more vivid and distinct. The addition of artificial feed using red dragon fruit skin is one way to enhance the color of koi fish [4]. Red dragon fruit skin contains anthocyanin, which is used as a natural pigment for the alternative red color in food products, substituting synthetic pigments and having a high antioxidant effect [5]. The carotenoid content in dragon fruit is about 0.005 to 0.012 mg per 100 grams [4]. Therefore, this research aims to determine the optimum concentration of red dragon fruit skin powder in artificial feed that can enhance the brightness of Sumatra fish color.

2. MATERIAL AND METHODS

2. 1. Time and Place of Research

This research was carried out in June 2023 to July 2023. This research took place at the laboratory of Building 2, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Indonesia.

2. 2. Material and Methods

The equipment used in this research includes a 39.5 × 25.0 × 27.5 cm^3 aquarium, aeration equipment, Toca Color Finder, digital scale, tray, pH meter, and DO meter. 150 Sumatra fish from Gede Bage, Bandung City, West Java, with sizes ranging from 2-3 cm, were used for the study. Commercial feed with the brand "Matahari" was used as the negative control, and the brand "Agaru" was used as the positive control, while red dragon fruit skin powder with

different concentrations was used. The research method employed was an experimental method with a Completely Randomized Design (CRD) consisting of 5 treatments and 3 replications. The treatments given in the experiment are as follows: (A) Commercial feed without red dragon fruit skin powder (negative control), (B) Commercial feed with the addition of 12.5% red dragon fruit skin powder, (C) Commercial feed with the addition of 15% red dragon fruit skin powder, (D) Commercial feed with the addition of 17.5% red dragon fruit skin powder, (E) Commercial feed with enhanced color formula without using red dragon fruit skin powder (positive control). The observation of color brightness changes was conducted every 10 days, over a period of 30 days, by observing five fish from each aquarium. Color observations were made using the Toca Color Finder. The assessment started from the lowest value of 1 to 7, with color gradations ranging from faded orange (TCF Code 0614) to dark orange (TCF Code 0916).

The observation of color brightness levels was conducted on the head, dorsal fin, and tail fin of the fish. The measurement of color brightness was carried out by three panelists who had a good understanding of ornamental fish colors and did not have color vision deficiencies (color blindness). These panelists had received prior training. The observation was done visually by comparing the fish's color to the Toca Color Finder. The result of the data were then analyzed using the Kruskal-Wallis test. If there were significant differences, the Test Z was conducted. Additional data regarding weight gain observations were analyzed using the F-test with a 95% confidence level to determine the treatment's effect on the parameter. If the treatment had a significant effect (F count > F table), it was continued by the Duncan's multiple distance test with a 95% confidence level to identify significant differences. Observations on survival rate (SR) and water quality were analyzed in a comparative descriptive manner.

3. EXPERIMENTAL AND RESULT

3. 1. The Level of the Head Color Changes from the Sumatra Fish

Based on the research carried out for 30 days, the addition of red dragon fruit skin powder increasing values the color score from Sumatra fish (**Figure 1)**.

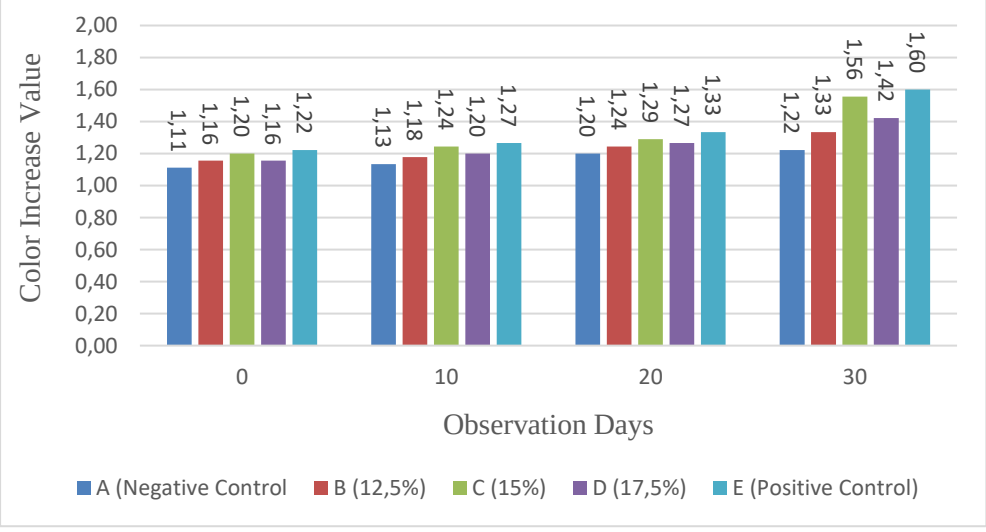
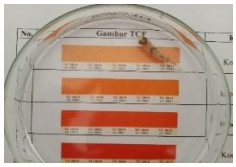
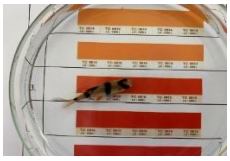
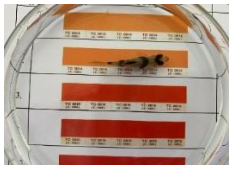
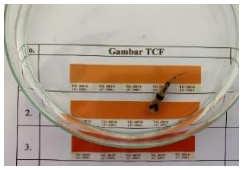
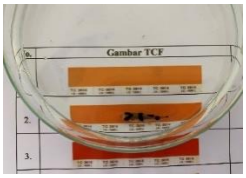
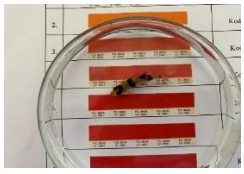


Figure 1. Color Increase Chart the Head of Sumatra fish from different treatments

The graph in Figure 1 shows that color enhancement is evident every day in treatments B, C, D, and E. This indicates that the addition of carotenoids present in red dragon fruit skin powder can influence the color brightness of Sumatra fish. In contrast, treatment A (negative control) without the addition of red dragon fruit skin powder showed a slight improvement compared to the other treatments. This is because fish that are not fed with carotenoid-containing feed have their chromatophore cells not spreading across their skin, resulting in a slower color improvement.

Table 1. Comparison of the Head Color Increase of Sumatra fish

Treatment	Day 0	Day 30
A. Negative Control (0%)		
B. (12,5%)		
C. (15%)		
D. (17,5%)		
E. Positive Control (0%)		

Observation on the 30th, the results indicated an increase in color for each treatment with the addition of red dragon fruit skin powder (Table 1). The highest color score was recorded in

treatment E, which is the positive control using specialized ornamental fish feed, with a score of 1.60, followed by treatment C with the addition of 15% red dragon fruit skin powder, achieving a score of 1.56. The addition of carotenoids found in red dragon fruit skin powder has proven to be highly effective in enhancing the color of koi fish [4].

Table 2. Color Increase of Head Sumatra Fish After Being Fed for 30 Days

Treatment	Day 0	Day 30	Increase in Color Value
A (Negative Control)	1,11±0,076	1,22±0,101	0,11±0,039[a]
B (Red Dragon Fruit Skin Powder 12,5%)	1,16±0,101	1,33±0,067	0,18±0,101[abc]
C (Red Dragon Fruit Skin Powder 15%)	1,20±0,067	1,56±0,138	0,31±0,156[bc]
D (Red Dragon Fruit Skin Powder 17,5%)	1.16±0,039	1,42±0,138	0,27±0,176[abc]
E (Positive Control)	1.22±0,138	1,60±0,133	0,38±0,214[c]

Description: Numbers followed by the same letter notation mean there is no real differences with a 95% confidence level.

The results presented in Table 2 indicate that the highest increase in the color of Sumatra fish occurred in treatment E, the positive control, with a significant but not significant difference compared to treatments B, C, and D, where red dragon fruit skin powder was added in amounts of 12.5%, 15%, and 17.5%. The lowest treatment was in treatment A, where no source of carotenoids was added to the feed. Treatment A had a value of 0.11 (Table 2), and the increase in color in the negative control treatment is likely due to the presence of other carotenoid-containing ingredients in the feed, such as fishmeal, which indirectly influences the color change in fish [6].

Physiologically, fish will change the pigments they get from their food, resulting in color variations. Physiological color changes caused by the movement of pigment granules or chromatophores [7].

3. 2. The Level of the Dorsal Fin Color Changes from the Sumatra Fish

Based on the research conducted over 30 days, the data indicates an increase in the color value of the dorsal fin of Sumatra fish fed with commercial feed containing red dragon fruit skin powder.

The observation of color changes in the dorsal fin of Sumatra fish reported an increase in color values. The highest increase in color values was observed in treatment E (Positive Control with specialized ornamental fish feed) and treatment C, with average color scores of 3.87 and 3.82 on the 30th day.

Treatment C had the highest score with the addition of red dragon fruit skin powder, averaging 3.82. This is likely due to the appropriate amount of carotenoid sources added in treatment C, which effectively enhanced the color of the dorsal fin of Sumatra fish.

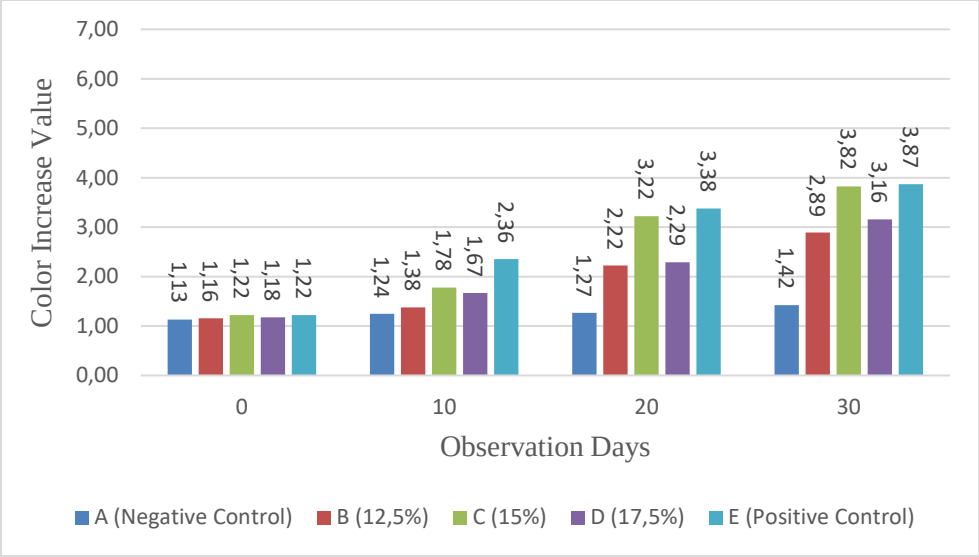
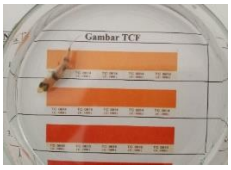
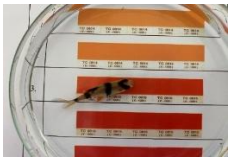
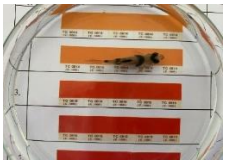
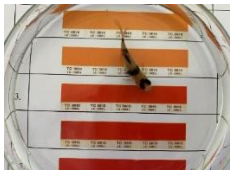
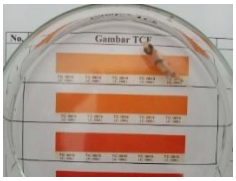
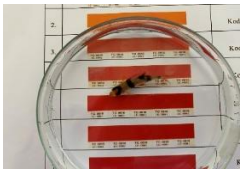
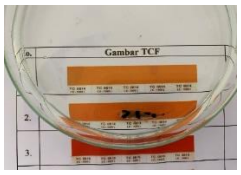


Figure 2. Color Increase Chart the Dorsal Fin of Sumatra fish from different treatments

Table 3. Comparison of the Dorsal Fin Color Increase of Sumatra fish

Treatment	Day 0	Day 30
A. Negative Control (0%)		
B. (12,5%)		
C. (15%)		
D. (17,5%)		

Treatment	Day 0	Day 30
E. Positive Control (0%)		

The observation of color changes in the dorsal fin of Sumatra fish reported an increase in color values. The highest increase in color values was observed in treatment E (Positive Control with specialized ornamental fish feed) and treatment C, with average color scores of 3.87 and 3.82 on the 30th day. Treatment C had the highest score with the addition of red dragon fruit skin powder, averaging 3.82. This is likely due to the appropriate amount of carotenoid sources added in treatment C, which effectively enhanced the color of the dorsal fin of Sumatra fish.

Table 4. Color Increase of Head Sumatra Fish After Being Fed for 30 Days

Treatment	Day 0	Day 30	Increase in Color Value
A (Negative Control)	1,13±0,067	1,42±0,101	0,29±0,076^{a}
B (Red Dragon Fruit Skin Powder 12,5%)	1,16±0,101	2,89±0,038	1,73±0,133^{a}
C (Red Dragon Fruit Skin Powder 15%)	1,22±0,138	3,82±0,101	2,60±0,230^{bc}
D (Red Dragon Fruit Skin Powder 17,5%)	1,18±0,101	3,16±0,076	1,98±0,167^{abc}
E (Positive Control)	1,22±0,101	3,87±0,067	2,64±0,076^{c}

Description: Numbers followed by the same letter notation mean there is no real differences with a 95% confidence level.

Based on the Kruskal-Wallis test, it was found that treatment E significantly differed from treatments B, C, and D but not significantly, indicating that the addition of red dragon fruit skin powder to commercial feed is acceptable. Treatments B, C, and D did not significantly differ, suggesting that treatment C is the most efficient. The addition of red dragon fruit skin powder mixed into the feed at a concentration of 15% had a positive effect on enhancing the color of comet fish [8]. Sumatra fish's absorption and metabolism of carotenoids contained in 15% red dragon fruit skin powder worked optimally because the concentration provided was suitable for the fish's ability to synthesize carotenoids.

Based on Table 4, it is evident that the highest color change values were observed in the dorsal fin compared to the head and tail fin of Sumatra fish. This is likely because the dorsal fin contains melanocyte-stimulating hormone (MSH), which is responsible for pigment changes. MSH can influence melanophore cells containing the pigment melanin, which plays a

role in all colors in fish. The number of pigment cells in a fish's body affects its color. If the pigment cells are evenly distributed, the fish's body color will appear more intense. However, if the pigment cells are concentrated in a single point, the body color will become pale.

3. 3. The Level of the Tail Color Changes from the Sumatra Fish

Based on the research conducted over 30 days, the data shows results indicating an increase in the color score of the tail fin in Sumatra fish when natural carotenoids from red dragon fruit skin powder were added to commercial feed at different concentrations.

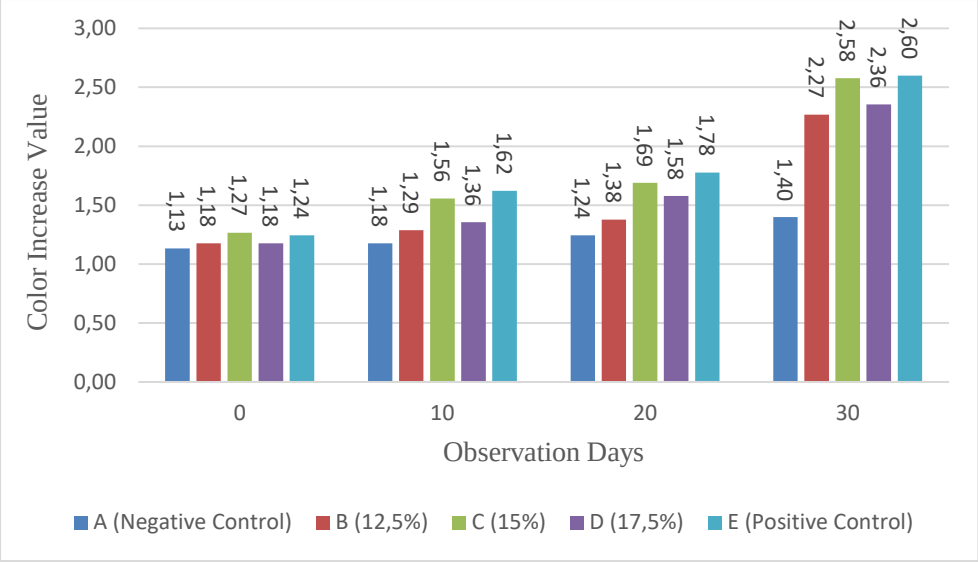
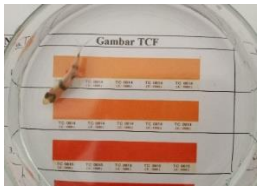
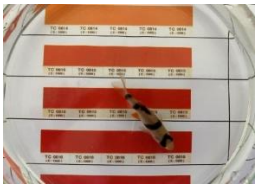


Figure 3. Color Increase Chart the Tail of Sumatra fish from different treatments

The highest increase in color values was observed in treatment E (Positive Control with specialized ornamental fish feed) and treatment C, with average color scores of 2.60 and 2.58 on the 30th day. Treatment C had the highest score with the addition of red dragon fruit skin powder, averaging 2.58. This is likely due to the appropriate amount of carotenoid sources added in treatment C, which effectively enhanced the color of the tail fin of Sumatra fish. The absorption of carotenoids in tissue cells affects the pigment cells (chromatophores) present in the fish's skin, resulting in increased coloration.

Table 5. Comparison of the Tail Color Increase of Sumatra fish

Treatment	Day 0	Day 30
A. Negative Control (0%)		

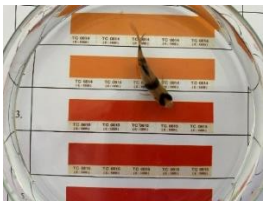
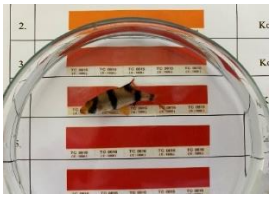
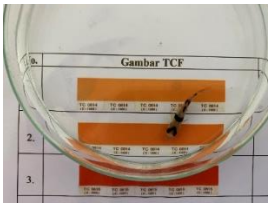
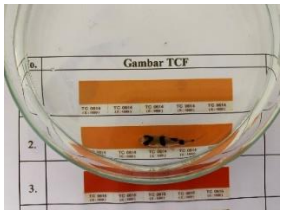
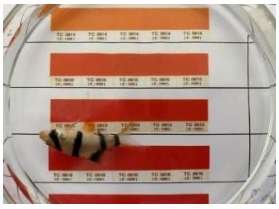
Treatment	Day 0	Day 30
B. (12,5%)		
C. (15%)		
D. (17,5%)		
E. Positive Control (0%)		

Table 6. Color Increase of Tail Sumatra Fish After Being Fed for 30 Days

Treatment	Day 0	Day 30	Increase in Color Value
A (Negative Control)	1,13±0,067	1,40±0,067	0,27±0,067[a]
B (Red Dragon Fruit Skin Powder 12,5%)	1,18±0,138	2,27±0,176	1,09±0,153[abc]
C (Red Dragon Fruit Skin Powder 15%)	1,27±0,067	2,58±0,203	1,31±0,192[bc]
D (Red Dragon Fruit Skin Powder 17,5%)	1.18±0,038	2,36±0,23	1,18±0,240[abc]
E (Negative Control)	1.24±0,101	2,60±0,067	1,36±0,138[c]

Description: Numbers followed by the same letter notation mean there is no real differences with a 95% confidence level.

Based on the results of the Kruskal-Wallis test, treatment E did not significantly differ from treatment C, suggesting that the addition of red dragon fruit skin powder to commercial

feed is acceptable. Treatments C and E did not significantly differ, so it can be concluded that treatment C, with the addition of 15% red dragon fruit skin powder, is the most efficient. Treatment E (Positive Control) showed a high color change value, likely due to specialized ornamental fish feed containing a balanced and well-formulated combination of vitamins, proteins, minerals, amino acids, and astaxanthin, which enhances the color brightness in fish. The carotenoids present in red dragon fruit skin can influence the level of color brightness in Sumatra fish. In each treatment, the highest color improvement occurred in treatment C (15%), indicating that the fish's carotenoid requirements were met. Since fish cannot produce carotenoids within their bodies, they must be supplied externally through their diet.

3. 4. Growth

Observation of absolute weight is a supporting parameter observed to determine the effect of red dragon fruit skin powder added to commercial feed on the growth of sumatra fish. Growth is an increase in volume and weight at a certain time. Fish growth is closely related to protein availability in the feed. The average growth of absolute fish weight in this study gave different result (**Table** 7).

Table 7. Absolute Weight Growth

Treatment	Average (g)
A (Negative Control)	1,427±0,071^{a}
B (Red Dragon Fruit Skin Powder 12,5%)	1,500±0,075^{ab}
C (Red Dragon Fruit Skin Powder 15%)	1,590±0,098^{ab}
D (Red Dragon Fruit Skin Powder 17,5%)	1,573±0,140^{ab}
E (Positive Control)	2,083±0,349^{c}

The absolute weight gain showed the highest results in treatment E (positive control with specialized ornamental fish feed), with 2.083 g, and treatment C (15% Red Dragon Fruit Skin Powder) with 1.590 g, while the lowest treatment was treatment A (negative control without the addition of red dragon fruit skin powder), with 1.427 g. The increase in carotenoid concentration in the feed indicates that the growth of Sumatra fish is not hindered by the addition of carotenoids present in red dragon fruit skin powder.

3. 5. Survival Rate

Observation of survival rate showed that the addition of red dragon fruit skin powder to commercial feed did not give a significant effect on the level of survival rate of Sumatra fish.

Table 8. Survival Rate of Sumatra Fish

Treatment	Survival Rate (%)
A (Kontrol Negatif)	80±0,00^{a}

B (Red Dragon Fruit Skin Powder 12,5%)	93±0,12[a]
C (Red Dragon Fruit Skin Powder 15%)	100±0,00[a]
D (Red Dragon Fruit Skin Powder 17,5%)	87±0,12[a]
E (Positif Control)	100±0,00[a]

Based on Table 8, it is evident that the addition of red dragon fruit skin powder to the feed for 30 days did not have a significant impact on the survival of Sumatra fish. The carotenoids naturally contained in red dragon fruit skin powder have vitamin A content that supports the regulation of body temperature, which in turn affects the health of the fish [9].

3. 6. Water Quality

Observation of water quality was conducted since it has a large influence upon cultivation. Water quality parameters observed in the study were temperature, DO, and pH. Observation of water quality in the research was conducted every 10 days. The result are presented in Table 9.

Table 9. Water Quality Observation Result for Sumatra Fish

Treatment	**Parameter**		
	Temperature (°C)	**DO (mg/L)**	**pH**
A	24– 24,5	5 – 5,5	7.5 – 7,9
B	24 – 24,6	5,3 – 5,6	7,6 – 7,9
C	24 – 24,7	5 – 5,5	7,6 – 7,9
D	24 – 24,6	5 – 5,6	7,6 – 7,9
E	24 – 24.7	5 – 5,7	7,5 – 7,9
Wibawa (2010)	22 – 28		
Harlena (2018)			6 – 8,0
SNI (2011)	20 – 26	>5	6,5 – 8,0

The temperature during the maintenance period ranged from 24 to 24.5 °C. This temperature range is within the tolerance limits because, according to [10], the optimal temperature range for Sumatra fish is 22 – 28 °C. The average dissolved oxygen (DO) levels observed during the study ranged from 5 to 5.7 mg/L. According to [11], a good dissolved oxygen level for Sumatra fish should be greater than 5 mg/L. The pH analysis during the study indicated that all treatments ranged from 7.5 to 7.9. The pH values during the study remained within the normal range. pH fluctuations occur due to the fish's metabolism during the study.

According to [1], Sumatra fish can survive within a pH range of 6 to 8. This is also consistent with the Indonesian National Standards, which state that the pH for koi fish maintenance should be in the range of 6.5 to 8.5. pH conditions that can disrupt fish life are either too low or too high [12].

4. CONCLUSION

A concentration of 15% red dragon fruit skin powder in the artificial feed is the optimal concentration that resulted in the highest color improvement for Sumatra fish: 0.31 on the head, 2.60 on the dorsal fin, and 1.31 on the tail fin.

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