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EVALUATION OF PUMPKIN PEEL POWDER (*Cucurbita moschata durch*) DIETARY SUPPLEMENTATION ON GROWTH AND COLOR IMPROVEMENT IN LEMON FISH (*Labidochromis caeruleus*)

EVALUASI SUPLEMENTASI TEPUNG KULIT LABU KUNING *(Cucurbita moschata durch)* PADA PAKAN TERHADAP PERTUMBUHAN DAN KECERAHAN WARNA IKAN LEMON *(Labidochromis caeruleus)*

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Abstract

This study aimed to determine the supplementation of yellow pumpkin peel powder on the coloration of lemon fish. The powder lemon fish with an average length of 3 cm and a weight of 0.83 g as many as 240 fish. This study used a completely randomized design (CRD) consisting of four treatments and four replicates, namely P1 (0 g/100 g feed), P2 (5 g/100 g feed), P3 (10 g/100 g feed), and P4 (15 g/100 g feed). The aquariums used were 50x30x30 cm in size, with 16 aquariums and 15 fish per aquarium. The fish were reared for 30 days and fed based on fish biomass. The parameters observed were growth performance (absolute weight, absolute length, and survival), water quality, feed nutrient levels, and increased color intensity. Data on growth performance and increased color intensity were analyzed using a one-way analysis of variance (one-way ANOVA) to determine the real difference between each treatment and followed by the Duncan multiple distance test (DMRT) with a 95% confidence interval ($p<0.05$). Water quality data and feed nutrient levels were analyzed descriptively. The results of the study showed that dietary supplementation with yellow pumpkin peel powder did not affect the growth performance of lemon fish, but it did affect the coloration of lemon fish. The best treatment for increasing the color of lemon fish was P4, with a color increase value of 31.5%.

Keywords: *Yellow pumpkin, Lemon fish coloration, Fish growth, Feed supplementation, Curcubitaxanthin*

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh suplementasi serbuk kulit labu kuning terhadap pewarnaan ikan lemon. Sebanyak 240 ekor ikan lemon dengan panjang rata-rata 3 cm dan bobot 0,83 g digunakan dalam penelitian ini. Penelitian menggunakan Rancangan Acak Lengkap (RAL) yang terdiri atas empat perlakuan dan empat ulangan, yaitu P1 (0 g/100 g pakan), P2 (5 g/100 g pakan), P3 (10 g/100 g pakan), dan P4 (15 g/100 g pakan). Akuarium berukuran 50×30×30 cm sebanyak 16 unit digunakan dengan kepadatan 15 ekor ikan per akuarium. Ikan dipelihara selama 30 hari dan diberi pakan berdasarkan biomassa ikan. Parameter yang diamati meliputi performa pertumbuhan (pertambahan bobot mutlak, panjang mutlak, dan tingkat kelangsungan hidup), kualitas air, kadar nutrisi pakan, serta peningkatan intensitas warna. Data performa pertumbuhan dan peningkatan intensitas warna dianalisis menggunakan analisis varians satu arah (one-way ANOVA) untuk mengetahui perbedaan nyata antarperlakuan, kemudian dilanjutkan dengan uji jarak berganda Duncan (DMRT) pada taraf kepercayaan 95% ($p<0,05$). Data kualitas air dan kadar nutrisi pakan dianalisis secara deskriptif. Hasil penelitian menunjukkan bahwa suplementasi serbuk kulit labu kuning dalam pakan tidak berpengaruh terhadap performa pertumbuhan ikan lemon, namun berpengaruh terhadap peningkatan pewarnaan ikan lemon. Perlakuan terbaik dalam meningkatkan warna ikan lemon adalah P4 dengan nilai peningkatan warna sebesar 31,5%.

Kata kunci: *Labu kuning, Pewarnaan ikan lemon, Pertumbuhan ikan, Suplementasi pakan, Curcubitaxanthin*

1. Introduction

Ornamental fish are a highly economical aquaculture business, providing profits for farmers and generating income for the country through export sales. The Ministry of Marine Affairs and Fisheries (KKP, 2021) noted that ornamental fish production has increased continuously from 1.19 billion fish in 2017 to 1.68 billion fish in 2019. The Central Statistics Agency (BPS) reported that the value of ornamental fish exports in 2012 was USD 21.01

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million and increased to USD 31.23 million in 2018 (Mustari, 2021).

Lemon Cichlid (*Labidochromis caeruleus*) is one example of an ornamental fish with high production value because it is in high demand among both enthusiasts and breeders (Octaviani *et al*., 2022). According to KKP (2017) *in* Indriastuti and Prigunawan (2020), in 2016, lemon fish production reached 310,000 fish, and in 2017, it reached 336,000 fish. Lemon fish often experience problems with their body color, where they are often found to be pale, even though the selling value of lemon fish itself is influenced by their body color. This statement is in accordance with the opinion of Rosid et *al. (*2019) that the brighter and more exotic the color, the more expensive the selling value of ornamental fish will be.

The brightness of a fish's color depends on the amount and location of pigments in the fish (Sally, 1997 *in* Hafiz *et al.,* 2020). The color of lemon fish can be enhanced by feeding them food containing color pigments (Phonna et al., 2022). The addition of chemical pigments to fish feed can have a negative impact on the surrounding environment if used continuously. Yaseen and Scholz (2019) argue that chemical dyes can produce hazardous waste that pollutes the soil, sediments, and surface water in the surrounding environment. This requires an alternative in the form of natural pigments, such as carotenoids. Carotenoids are obtained from plants or fruits, such as pumpkin (*Cucurbita moschata durch)*.

Pumpkin is a fruit that contains high levels of carotenoids, namely 180,000 SI (Ibnu *et al.,* 2015). Pumpkin is often used in research on fish color brightness due to its content, and the skin of the pumpkin is considered waste. The waste from yellow pumpkin skin can also be used as an antioxidant and to enhance the color brightness of fish. This statement is supported by the results of phytochemical screening tests of yellow pumpkin skin extract, which found that yellow pumpkin skin contains flavonoids, alkaloids, saponins, and terpenoids (Indriyanti *et al.,* 2018). Hibrizi's (2023) research shows that the addition of yellow pumpkin flour in feed affects the color brightness of comet fish. The increase in color brightness ranged from 8.57% to 10.51%, with the best treatment being P4 at 10.51.

There has been no research on the effects and potential for improving the color of lemon fish by adding yellow pumpkin peel flour to feed. This requires further research on the addition of yellow pumpkin peel flour in feed for the growth and color improvement of lemon fish. Research is also being conducted to utilize yellow pumpkin peel waste so that it can increase the economic value of both pumpkins and lemon fish.

2. Materials and Methods

2.1. Time and Place

This research was conducted in November-December 2024. Fish maintenance was carried out at the Potrobangsan Fish Seed Center, North Magelang District, Magelang City, Central Java. Other activities were carried out at the Integrated Laboratory of Tidar University, North Magelang, Magelang City, Central Java.

2.2. Preparation of Research Containers

The containers used in this study were 16 aquariums measuring 50x30x30 cm. Before being used for research, the aquariums were washed and scrubbed with soap and running water until clean and then drained (Peo *et al*., 2023). Next, the aquariums were filled with 15 liters of water, and an aerator was installed as an oxygen supply. The aquariums were coded according to the research container placement pattern. The lemon fish were ready to be placed in the aquariums at a density of 1 fish/liter. This study used 15 lemon fish measuring 3-4 cm per aquarium, which were obtained from the Sasana Mina fish market.

2.3. Preparation of Test Fish

Test fish preparation was carried out by purchasing and selecting lemon fish that were uniform in size (3-4 cm) and free from disease. The fish were first adapted for two weeks by feeding them pellets without pumpkin skin flour, so that the fish would not be stressed and remain healthy (Ginting *et al.,* 2014). A total of 240 fish were used, with a stocking density of 15 fish per aquarium.

2.4. Test Feed Preparation

The preparation of test feed involved two stages: making yellow pumpkin skin flour and mixing the flour with commercial feed.

a. Production of Yellow Pumpkin Skin Flour

The production of pumpkin flour begins with washing the pumpkins until they are clean, followed by peeling the skin from the pumpkins using a knife. The separated skin is cut into small pieces to facilitate the drying process. The skin is dried in the sun for approximately two days until it is dry. If it is not dry enough, it is oven-dried at 80°C for 12 hours. After drying, the pumpkin skin is blended. Then it is sifted.

b. Mixing pumpkin flour into feed

The feed used in the study was Agaru brand floating ornamental fish pellet feed with a protein content of 35-40% (Yunaidi and Wibowo, 2019). The feed was mixed with pumpkin peel flour according to the treatment dosage. The method used in the mixing process was the *coating* method. According to Wahyu (2024), the *coating* method is a method of mixing pellet feed with certain treatments using egg whites. The pellets were mixed with yellow pumpkin peel flour and egg white, then heated in an oven for 3-4 hours at$^{60°C}$. After the coating process, the feed was analyzed for its nutrient content through proximate analysis, as shown in Table 1.

Table 1.
Proximate analysis of feed

Treatment (dose)	Content Tested (%)				
	Moisture Content	Ash Content	Protein*	Fat	Crude Fiber
P1 (Control)	6.3661	10.1121	17.4058*	2.9454	5.8412
P2 (5%)	7.3471	9.6604	14.4171*	3.1140	6.759
P3 (10%)	8.0713	9.5842	14,098*	3.5415	7.5887
P4 (15%)	8.0328	9.3127	13.4534*	3.6183	8.2162

2.5 Test Fish Maintenance

Test fish maintenance was carried out for 30 days at BBI Potrobangsan. Feeding during the study was carried out three times a day, namely at 8:00 a.m., 12:00 p.m., and 4:00 p.m. The feeding method used in this study was *ad satiation* (feeding was stopped when the fish were full) (Mandani, 2017). The aquarium treatment itself was carried out three times a week. Twenty percent of the total water in each aquarium was siphoned (Ismayadi *et al.,* 2016). Water quality data collected included temperature, pH, and dissolved oxygen. Water temperature was measured using a thermometer, acidity (pH) was measured using a pH meter, and dissolved oxygen (DO) was measured using a Dometer. During fish maintenance, water quality is controlled within a range of 23.7-27.1°C temperature, 7.1-8.1 pH, and 4.8-5.8 mg/l DO (Urbasa, 2015; Alfatihah *et al.,* 2022).

2.6. Fish Sample Data Collection

Fish sample data collection was conducted twice, at the beginning and end of the rearing period. The brightness of the

lemon fish color was observed by photographing the fish using a DSLR camera and then matching the grid code in the Photoshop application. This statement is in accordance with the opinion of Virgiawan *et al.* (2020), that the brightness of fish color can be observed visually with a DSLR camera and then analyzed using the color gradation conversion method using the *Adobe Photoshop CS5* application.

2.7. Data Analysis

2.7.1 Absolute Length Growth

According to Julaini *et al.* (2023), the absolute length growth of fish is calculated using the formula:

$$Pm = Pt - P0$$

Explanation:
Pm : Absolute length of fish (cm)
Pt : Length of fish at the end (cm)
P0 : Initial length of fish (cm)

2.7.2 Absolute Weight Growth

According to Sartikawati *et al.,* (2020), absolute weight growth is calculated using the formula:

$$W = Wt - W0$$

Explanation
W : Absolute weight (g)
Wt : Final biomass (g)
W0 : Initial biomass (g)

2.7.3 Specific Growth Rate (SGR)

The specific growth rate of lemon fish according to Ismayadi *et al.* (2016) is calculated using the following formula:

$$SGR = \frac{Ln(Wt) - Ln(Wo)}{t} \times 100\%$$

Explanation:
SGR : Specific Growth Rate (%)
Wt : Final fish weight at harvest (g)
Wo : Initial fish weight at the start of cultivation (g)
t : Duration of rearing (days)

2.7.4 Survival Rate

The calculation of survival rate or survival of lemon fish fry at the end of the study according to Virgiawan *et al.,* (2020) is as follows:

$$SR = \frac{Nt}{No} X\ 100\%$$

Explanation:
SR : Survival rate (%)
Nt : Total fish at the end (number)
N0 : Total fish at the beginning (tails)

2.7.5 Fish Color

The observation of the brightness of the color of lemon fish in this study used the *Adobe Photoshop CS.6* application to determine the color code for each fish sample that had been photographed using a DSLR camera. According to (Yaeni and Yuniarti 2017), the first step when entering the Photoshop application is to click *view*, then click *show*, and select grid. *The eyedropper tool* in this application is used to select colors in the image to be observed. Click on the desired point, and the color code for that image will appear. The color code from this tool is used to obtain colors that are exactly the same as the original. Fish samples were taken twice, at the beginning and end of the study, with 4 fish per treatment. The method for measuring the color percentage score on fish using the *Adobe Photoshop CS.6* application is to insert a photo of the fish into the application, then a box will appear on the entire body of the fish with different numbers and color codes. The color code will appear when you click on each box in the image, then it is recorded.

The calculation was performed after all codes in each sample were completed. The calculation was performed by adding up the percentage of each code by adding up the boxes in the color code divided by all the boxes obtained and multiplied by 100%, which would produce the percentage for each color code. The color calculation can use the following formula:

$$\text{Grid Code} = \frac{\text{Jumlah grid per kode}}{\text{Jumlah total grid}} X\ 100\%$$

The calculated color percentage results are then averaged for each treatment. To determine the treatment that provides the best color improvement, the final color calculation is subtracted from the fish color at the beginning of the study, and the results are presented in a table and as a percentage.

2.8 Water Quality Measurement

Temperature, pH, and dissolved oxygen measurements were conducted *in situ* at 8:00 AM and 4:00 PM.

3. Results and Discussion

3. Fish Growth Rate

Based on the research results, the average absolute length growth of lemon fish presented in Table 2 obtained the highest value in treatment P4 (0.41 cm), and the lowest value was obtained in P1 (0.38 cm).

Table 2.
Growth Parameter, SGR, and SR Results

Parameters	P1	P2	P3	P4
Absolute Length (cm)	0.38±0.01	0.39±0.01	0.40±0.01	0.41±0.01
Absolute Weight (g)	0.24±0.03	0.29±0.09	0.33±0.04	0.36±0.06
SGR (%/day)	0.84±0.14	1.00±0.32	1.12±0.15	1.21±0.21
SR (%)	82.75±11.64	84.5±12.76	86.25±9.42	88±15.03

The data obtained on absolute length continued to increase in each treatment. The results of the absolute weight presented in Table 2 were the same as the absolute length data, which continued to increase in each treatment. The highest absolute weight was obtained in treatment P4 (0.36 g) and the lowest value was obtained in P1 (0.24 g). The absolute length and absolute weight data in this study both increased, presumably because lemon fish consumed different feed contents according to the proximate results in Table 1. According to Masitoh (2015), the higher the protein value of a feed, the more efficient the use of that feed protein in supporting growth. This statement is not consistent with the results of this study, because the protein content obtained decreased inversely proportional to the increasing growth data. This could be because other nutrients such as fiber, fat, water, and ash content increased with treatment (Table 1). Higher doses of feed nutrients are better, except for protein content. The " " is thought to be the reason why weight and length growth increased.

Gunawan and Khalil (2015) stated that each fish species requires different protein levels because protein requirements are influenced by the size and age of the fish, but in general, fish require feed with a protein content of around 30-50%. Some carnivorous fish require protein levels of around 40-55%. The protein results obtained in Table 1 do not meet the standard; therefore, even though the value decreased, it did not affect the growth of lemon fish, which increased. This is reinforced by Pratama (2021), who states that if the fat in the feed does not meet the fish's needs, the energy for activity is taken from protein, thereby inhibiting the body's metabolism. The fat content obtained in the proximate results in Table 1 shows that the higher the treatment, the better the results. Therefore, even though the protein is high, if the fat content is low, the fish cannot absorb the nutrients in the feed for maximum growth.

The results of the ANOVA for absolute length and absolute weight showed no significant differences. These results are in line with Safrida's (2017) research, which found that pumpkin affects fish color but has no significant effect on fish length and weight. This is reinforced by Nazhira *et al.'s* (2017) research, which found that the addition of carotenoids to feed has no effect on growth and that ornamental fish fed with carotenoid sources are thought to utilize these pigments to enhance their body color rather than for significant physical growth.

Based on the results of the ANOVA calculation of the growth rate, it was found that the addition of yellow pumpkin peel powder to the feed did not have a significant effect on the specific growth rate of the fish. The differences in the average SGR results in P1, P2, P3, and P4 (Table 2) may occur due to the fish's ability to digest the feed given, according to Johan (2018), who stated that the growth rate is related to the accuracy of the amount of feed given to the stomach capacity and the speed of stomach emptying. This is reinforced by the opinion of Diana and Safutra (2018), that specific growth rate is closely related to body weight growth derived from the feed provided.

Based on the survival rate calculations shown in Table 2, the SR value obtained is quite good, which can be attributed to the fact that the value obtained is above 82%. According to Irmadiati *et al.* (2021), a *survival rate* value in fish farming >50% is considered good, a value of 30-50% is considered moderate, and a survival rate value below 30% is considered poor. Table 2 shows that the highest survival rate value is found in P4 with a dose of 15%. These results are consistent with the research by Sartikawati *et al.* (2020), which found that the addition of 15% pumpkin flour resulted in the best survival rate data. According to Sartikawati *et al.* (2020), fish survival is influenced by biotic and abiotic factors. Biotic factors that influence survival include competitors, parasites, age, predation, population density, the adaptability of animals, and human handling. Abiotic factors that influence survival include the physical and chemical properties of the aquatic environment. Fish survival, especially during the larval and fry stages, is largely determined by food availability and environmental conditions. The ANOVA results for fish survival showed no significant difference, which may be due to low survival rates affecting the ANOVA calculations.

3.2. Improvement in Fish Color

Based on the data on the improvement in the color quality of lemon fish presented in Figure 6, it was found that the P1 to P4 values continued to increase. P1 had the lowest value (7.5), while P2 had a value of 12.7, P3 had a value of 20.5, and the highest treatment was obtained in P4 with a dose of 15% (31.5).

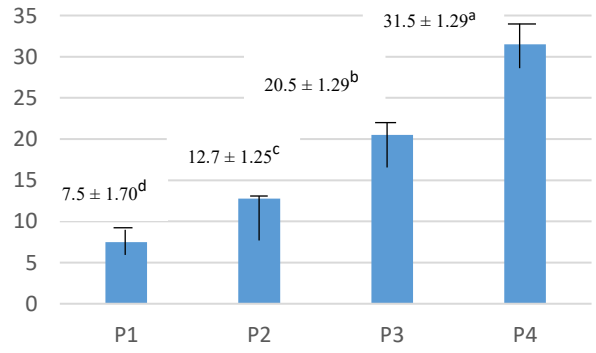

Figure 1. Color brightness analysis results

The results obtained are in accordance with the results of the study by Julaini *et al.,* (2023), where the best treatment was obtained from treatment D (70% pellets, 15% carrot flour, and 15% pumpkin flour), which produced the best color change rate. This is reinforced by the research of Sartikawati *et al.* (2020), which found that the highest treatment was P3, namely the addition of 15% pumpkin flour, with a color change of 1.2631.

The addition of yellow pumpkin skin flour at doses of 0%, 5%, 10%, and 15% proved that the more doses given in fish feed would increase the brightness of the color of lemon fish. The content found in yellow pumpkin skin flour in the form of carotenoids is capable of producing yellow or dark orange pigments that bring out the color on the body of lemon fish. According to Andriani *et al.* (2018), the main components that form red, orange, and yellow pigments are carotenoid pigments. Carotenoids are natural substances that are soluble in fat or organic solvents but not soluble in water.

According to Khalil *et al.* (2023), the mechanism of color formation in fish begins with feed containing colorants that are consumed by the fish. The colorants in the small intestine are broken down by the mucosal cells through diffusion, forming bubbles that are then absorbed through the lymphatic system, transported into the blood, and carried to the liver. Once in the liver, the pigments are synthesized and stored in the form of retinyl palmitate. When needed by the body, the pigments are transferred to proteins and transported to tissue cells, so that the carotenoids are absorbed by the chromatophores. All pigments that enter the chromatophores are controlled by the enzyme tyrosinase. The tyrosinase enzyme synthesizes the pigment that enters the chromophore cells, which work to promote and change the coding of pigment patterns. The movement and number of different chromophores will affect the brightness of the fish's color.

According to Noviyanti and Maharani (2015), if pigment cells are evenly distributed throughout the fish's body, the fish will appear brighter or more intense, while pigment cells that are not distributed and accumulate in one spot on the fish will cause the fish to appear paler. The results of this study found that the best treatment was P4 with the highest dose of 15% and the lowest was P1 with a control dose. The P4 treatment is thought to have more pigment cells than the others, and is able to spread evenly and produce deep yellow and orange colors.

Another factor causing differences in color brightness in lemon fish is the fish's ability to absorb color pigments. The treatment dose given was suspected to be in accordance with the needs of lemon fish, where the 15% dose treatment obtained the best results compared to the lower doses (10%, 5%, and 0%). This was suspected to be due to the absorption capacity of lemon fish and the amount of carotenoid content at a dose of 15% that could meet pigment requirements, so that the pigment absorption process took place perfectly and produced a deep color and not pale. This opinion is supported by the statement of Lestari *et al.* (2019), that fish need more time to break down carotenoids into color pigments when the amount of carotenoids in the feed is higher, and vice versa.

Based on the results of the ANOVA color analysis, it can be concluded that yellow pumpkin peel flour added to lemon fish feed has a significant effect on increasing the color of the fish's body. This is evidenced by the Fcount (331.476) > Ftable (3.49) results. This is thought to be because the addition of pumpkin peel flour to fish pellets contains sufficient pigments (carotenoids) to help improve the color of lemon fish. According to Saini *et al.* (2015), yellow pumpkin has the highest lycopene content, which is 7 µg/kg dry weight, and also contains 175 µg/kg dry weight of lutein. Lutein itself is part of the carotenoid that gives a yellow color (Kaur and Shah, 2017).

The ANOVA results showed a significant effect, which was then followed by Duncan's test. The results of Duncan's test on the brightness of the lemon fish color showed different

notations in each treatment, which means that there was a different increase in color in each treatment. This could be due to differences in the dosage of yellow pumpkin peel powder given (0%, 5%, 10%, and 10%), meaning that the fish's absorption capacity of the feed was also different, and the results obtained were also different. According to Satyani & Sugito (1997) *in* Adriani *et al.* (2018), the appearance of color in fish is influenced by the content and ability or absorption capacity of fish to the pigment source given.

4. Conclusion

Based on the research results, it was concluded that the addition of yellow pumpkin peel powder in lemon fish feed did not affect growth but did affect the color enhancement of lemon fish. The optimal dose of yellow pumpkin peel flour for enhancing the color of lemon fish is P4 (15%), with a 30.7% increase in fish color. The addition of carotenoids to feed does not affect growth, because ornamental fish utilize these pigments more to enhance their body color than for significant physical growth.

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