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EFFECTIVENESS OF VARIOUS CARROT FLOUR COMBINATION RATIOS IN COMMERCIAL FEED ON IMPROVING COLOR AND GROWTH PERFORMANCE OF GOLDFISH *(Carassius auratus)*

Efektivitas Berbagai Rasio Kombinasi Pakan Komersial Dan Tepung Wortel Terhadap Kecerahan Warna Dan Pertumbuhan Ikan Mas Koki *(Carassius auratus)*

Kadek Ade Sutawan*, Alexander Korinus Marantika, Made Dwipa Kusuma Maharani

Department of Marine Biology and Fisheries, Faculty of Mathematics and Natural Sciences, Ganesha University of Education

Jalan Udayana, Singaraja, Kabupaten Buleleng, Bali, Indonesia

*Corresponding Author: Ade.sutawan@student.undiksha.ac.id

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ABSTRACT

Goldfish (*Carassius auratus*) is an ornamental fish commodity with high economic value, whose market price is significantly influenced by visual quality, particularly color brightness. This study aimed to analyze the effect of adding carrot meal (*Daucus carota*) to commercial feed on the color brightness and growth of goldfish, as well as to determine the most optimal dose. The research was conducted for 60 days in Tukadmungga Village, Buleleng Regency, Bali, using a Randomized Block Design (RBD) with four treatments and three replications. The treatments administered were A (100% commercial feed), B (85% commercial feed + 15% carrot meal), C (80% commercial feed + 20% carrot meal), and D (75% commercial feed + 25% carrot meal). The observed parameters included color brightness, absolute growth in length and weight, specific growth rate (SGR), feed conversion ratio (FCR), survival rate (SR), and water quality. Data were analyzed using ANOVA at a 95% confidence level, followed by Duncan's multiple range test. The results showed that the addition of carrot meal had a significant effect on improving the color brightness of goldfish ($P < 0.05$), with the highest increase observed in treatment D at 0.73 ± 0.08. However, treatments C (20%) and D (25%) were not significantly different; thus, the 20% dose was considered optimal. The addition of carrot meal did not significantly affect growth, SGR, or FCR ($P > 0.05$). The survival rate ranged from 87–100%, and water quality remained within the optimal range. Carrot meal has the potential to be used as a natural source of carotenoids to enhance the color brightness of goldfish without compromising growth and feed efficiency.

Keywords: *Carassius auratus*, Carrot meal, Color brightness, Growth, β-Carotene.

ABSTRAK

Ikan mas koki (*Carassius auratus*) merupakan komoditas ikan hias bernilai ekonomi tinggi yang nilai jualnya sangat dipengaruhi oleh kualitas visual, terutama kecerahan warna. Penelitian ini bertujuan untuk menganalisis pengaruh penambahan tepung wortel (*Daucus*

carota) pada pakan komersial terhadap kecerahan warna dan pertumbuhan ikan mas koki serta menentukan dosis yang paling optimal. Penelitian dilaksanakan selama 60 hari di Desa Tukadmungga, Kabupaten Buleleng, Bali, menggunakan Rancangan Acak Kelompok (RAK) dengan empat perlakuan dan tiga ulangan. Perlakuan yang diberikan meliputi A (100% pakan komersial), B (85% pakan komersial + 15% tepung wortel), C (80% pakan komersial + 20% tepung wortel), dan D (75% pakan komersial + 25% tepung wortel). Parameter yang diamati meliputi kecerahan warna, pertumbuhan panjang dan berat mutlak, laju pertumbuhan spesifik (SGR), rasio konversi pakan (FCR), tingkat kelangsungan hidup (SR), dan kualitas air. Data dianalisis menggunakan ANOVA pada taraf kepercayaan 95% dan dilanjutkan dengan uji Duncan. Hasil penelitian menunjukkan bahwa penambahan tepung wortel berpengaruh nyata terhadap peningkatan kecerahan warna ikan mas koki ($P<0,05$), dengan peningkatan tertinggi pada perlakuan D sebesar 0,73 ± 0,08. Namun, perlakuan C (20%) dan D (25%) tidak berbeda nyata, sehingga dosis 20% dianggap optimal. Penambahan tepung wortel tidak berpengaruh nyata terhadap pertumbuhan, SGR, maupun FCR ($P>0,05$). Tingkat kelangsungan hidup berkisar 87–100% dan kualitas air berada pada kisaran optimal. Tepung wortel berpotensi digunakan sebagai sumber karotenoid alami untuk meningkatkan kecerahan warna ikan mas koki tanpa mengganggu pertumbuhan dan efisiensi pakan.

Kata Kunci: *Carassius auratus*, Kecerahan Warna, Pertumbuhan, Tepung Wortel, β-Karoten.

INTRODUCTION

Goldfish (*Carassius auratus*) are a freshwater ornamental fish with high economic value and widespread demand. The primary attraction of goldfish lies in their unique body shape and bright, attractive coloration. In ornamental fish farming, color quality is a crucial parameter determining market value and consumer preference. In addition to color brightness, growth is also an indicator of successful farming because it is related to productivity and business efficiency. However, goldfish color quality and growth are not always optimal due to the limited natural pigment content in commercial feeds routinely used by fish farmers.

Fish body color is influenced by the presence of chromatophore cells containing pigments, particularly carotenoids, which produce yellow, orange, and red colors. Fish are unable to synthesize carotenoids optimally, so these pigments must be obtained through their diet. Consumed carotenoids are absorbed through the digestive tract, distributed to body tissues, and stored in chromatophores, enhancing the intensity of the fish's color. In addition to their role in pigmentation, carotenoids also function as antioxidants and contribute to fish health. Therefore, adding natural carotenoid sources to feed is one strategy that is widely applied to improve the color quality of ornamental fish..

One potential source of natural carotenoids is carrots (*Daucus carota*). Carrots contain high amounts of β-carotene which functions as a precursor to vitamin A as well as a source of natural pigment. Compared to synthetic dyes, using carrot flour is relatively safer, easier to obtain, environmentally friendly, and has a more economical cost. Apart from that, the nutrient content in carrots has the potential to support fish metabolism and growth processes. The use of carrot flour as a feed additive is expected to improve the color quality of fish while maintaining optimal growth performance.

Various studies have proven the effectiveness of carrot flour in improving the color quality of fish. Budi & Mardiana (2021) reported that adding carrot flour to koi fish feed can significantly increase growth and brightness of body color. Firdaus *et al*. (2022) showed that 15% carrot flour supplementation increased the brightness of koi fish color although it did not have a real effect on growth. Research by Marnani *et al*. (2022) on guppy fish showed that the addition of carrot flour was able to improve color quality with the best results at a dose of 10%. Similar results were also reported by Bani *et al*. (2022) in clownfish (*Amphiprion percula*) and

Mukti *et al*. (2022) in Sumatran fish (Puntius tetrazona), where providing a source of carotenoids from carrots was proven to increase color brightness and support the growth performance and survival of the fish.

Although various studies have shown the benefits of carrot flour in several fish species, information regarding its use in goldfish is still relatively limited, especially regarding the effective addition dose to increase color brightness without reducing growth performance. Differences in metabolic abilities and utilization of carotenoids between species mean that the results of research on one type of fish cannot necessarily be applied directly to other species. Therefore, research is needed that specifically evaluates the effect of adding carrot flour to commercial feed on color brightness and growth of goldfish.

This research aims to analyze the effect of adding carrot flour (*Daucus carota*) to commercial feed on the color brightness and growth of goldfish (*Carassius auratus*) and determine the dose that provides the most optimal results. In general, this research is based on the assumption that increasing the proportion of carrot flour in feed can increase the color intensity of fish through increasing carotenoid intake, but at certain doses it can affect the efficiency of nutrient utilization related to growth. It is hoped that the results of this research can become the basis for developing functional feed made from natural ingredients that can improve the quality and economic value of goldfish in cultivation activities.

RESEARCH METHODS

Place and Time of Research

The research was conducted in Dharma Yadnya Hamlet, Tukadmungga Village, Buleleng District, Buleleng Regency, Bali, and lasted for 60 days, from February to April 2026.

Tools and Materials

Alat The tools used included a 15L plastic jar, an aerator, a filter, a digital scale, a ruler, Modified Toca Color Finder (mTCF) paper, a thermometer, a pH meter, a DO meter, an ammonia test kit, a camera, a cleaning tool, and stationery. The research materials consisted of 60 orange goldfish (*Carassius auratus*) measuring approximately 5 cm and weighing 3-4 g, carrot flour (*Daucus carota*), commercial feed (Prima Feed FP800), and egg white as a feed binder.

Research Design

The research used an experimental method with a Randomized Block Design (RBD) consisting of four treatments and three replications. Each experimental unit contained five fish, resulting in a total of 60 fish. The treatments given were:

A : 100% commercial feed
B: 85% commercial feed + 15% carrot flour
C: 80% commercial feed + 20% carrot flour
D: 75% commercial feed + 25% carrot flour

Research Procedures

Before the study began, the fish were acclimatized for seven days. The rearing tank was cleaned and filled with 10 L of water, equipped with aeration and filtration. The treatment feed was prepared by mixing carrot flour according to the treatment dosage into commercial feed using egg white as a binding agent, then dried until ready for use.

The fish were reared for 60 days at a density of five fish per tank. Feed was provided at a rate of 3% of the fish biomass per day, divided into two feedings: morning and evening. Feed adjustments were made every 30 days based on the results of fish biomass weighing.

Color brightness was observed at the beginning of the study, on the 30th day, and on the 60th day using the Modified Toca Color Finder (mTCF) scoring method. Assessments were

conducted by five panelists by comparing the fish's body color against the mTCF color scale. Additionally, visual documentation was conducted using a camera under uniform lighting and background conditions.

The growth parameters observed included absolute weight gain, absolute length gain, feed conversion ratio (FCR), and survival rate (SR). Water quality monitored includes temperature, pH, dissolved oxygen (DO), and ammonia, measured weekly. Water changes of 20–30% of the total tank volume are performed weekly.

Data Analysis

The parameters observed included color brightness, absolute weight gain, absolute length gain, feed conversion ratio (FCR), and survival rate (SR). Absolute weight gain was calculated using the formula based on Effendie (1979):

$$W_m = W_t - W_o$$

with W_m= absolute weight growth (g), W_t= final weight (g), and W_o= initial weight (g). Absolute length growth is calculated using the formula Zonneveld *et al*, (1991):

$$P_m = L_t - L_o$$

Where P_m= a bsolute length growth (cm), L_t= final length (cm), dan L_o= initial length (cm). The feed conversion ratio is calculated using Stickney's (1994) formula, as follows:

$$FCR = \frac{F}{(Wt + D) - Wo}$$

where F = Total amount of feed given (grams), Wt= Fish weight at the end of the study (grams).

Survival was calculated using Effendie's formula (1979):

$$SR = \frac{N_t}{N_o} \times 100$$

where *SR*= survival rate (%), N_t= number of live fish at the end of the study, and N_o= number of fish at the beginning of the study.

Data Data were analyzed using SPSS software. Prior to the main analysis, data were tested for normality and homogeneity. Data that met the assumptions were analyzed using one-way Analysis of Variance (ANOVA) at a 95% confidence level (α = 0.05). If significant differences were found between treatments, Duncan's test was used to determine the differences between treatments.

RESULTS

The results obtained included data on color brightness increase, absolute length growth, absolute weight growth, specific growth rate (SGR), feed conversion ratio (FCR), survival rate (SR), and water quality.

Changes in goldfish color brightness during the rearing period can be seen in Table 1.

Table 1. Increase in Goldfish Color Brightness During the Study

Treatment	Early Score	Final Score	Brightness Enhancement
A (0% carrot flour)	19,00	19,00 ± 0,00	0,00 ± 0,00
B (15% carrot flour)	19,00	19,48 ± 0,04	0,48 ± 0,04

C (20% carrot flour)	19,00	19,67 ± 0,06	0,67 ± 0,06
D (25% carrot flour)	19,00	19,73 ± 0,08	0,73 ± 0,08

Note: Values are presented as mean ± standard deviation.

The results showed that the highest increase in color brightness was achieved in treatment D (25% carrot flour), with an average increase of 0.73, while the control treatment showed no increase in color brightness.

The ANOVA analysis showed that the addition of carrot flour to commercial feed significantly increased the color brightness of goldfish ($P<0.05$), with a significance value of 0.007. Differences in color brightness increase between treatments were further analyzed using the Duncan test, as shown in Table 2 below.

Table 2. Color Brightness Improvement (Duncan Advanced Test)

		Subset for alpha = 0.05	
Treatment	**N**	**1**	**2**
Control (A)	-	-	-
B (15%)	3	0.4800	
C (20%)	3		0.6667
D (25%)	3		0.7333

Based on the results of Duncan's further test, Treatments C (20%) and D (25%) were not significantly different (in Subset 2), but both produced a significantly higher increase in color brightness compared to Treatment B (15%) in Subset 1.

The average absolute length and absolute weight growth of goldfish during the study are presented in the following diagram.

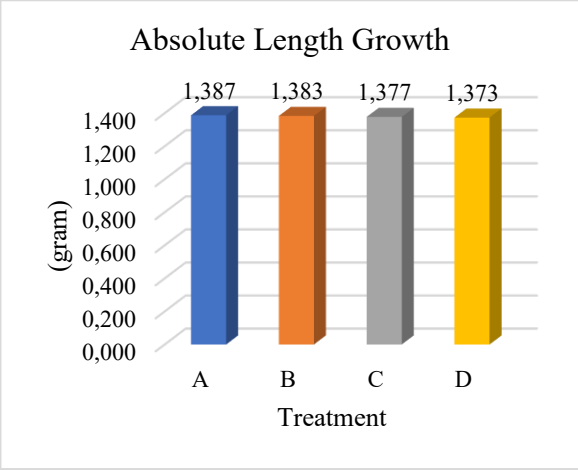

Figure 1. Absolute Length Growth Diagram of Goldfish

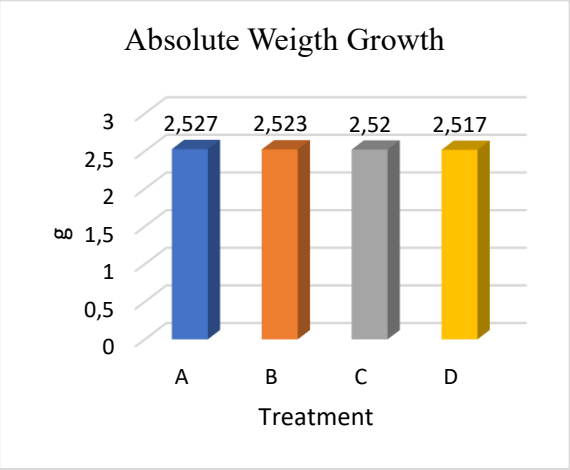

Figure 2. Absolute Weight Growth Diagram for Goldfish

The highest absolute length growth was achieved in treatment A, at 1.387 cm, while the lowest value was achieved in treatment D, at 1.373 cm. Although there was a tendency for length growth to decrease with increasing carrot flour dosage, ANOVA analysis results showed that the treatments had no significant effect on absolute length growth of goldfish ($P>0.05$) with a significance value of 0.999.

The highest absolute weight growth was achieved in treatment A, at 2.527 g, and the lowest in treatment D, at 2.517 g. The ANOVA analysis results showed that the addition of carrot flour had no significant effect on absolute weight growth of goldfish (P>0.05) with a significance value of 0.998.

The specific growth rate (SGR) and feed utilization efficiency of goldfish during the study are presented in the following chart.

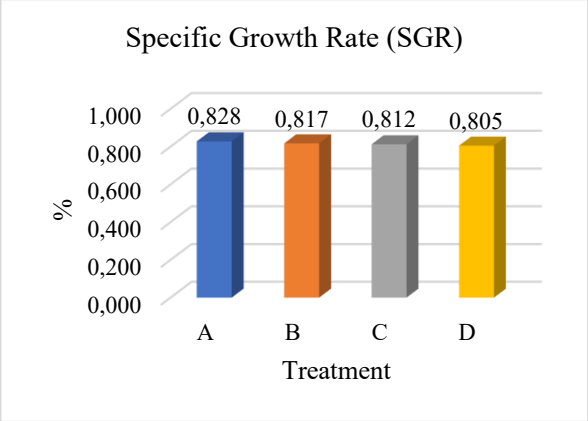

Figure 3. Specific Growth Rate Diagram of Goldfish

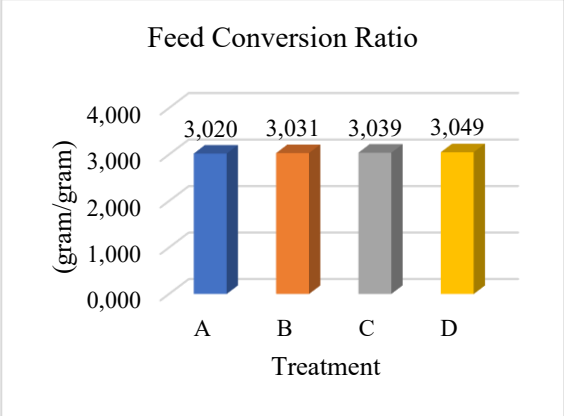

Figure 4. Feed Conversion Ratio Diagram

The highest SGR value was obtained in treatment A at 0.828%/day, and the lowest in treatment D at 0.805%/day. ANOVA analysis results showed that the addition of carrot flour had no significant effect on the SGR value of goldfish (P>0.05) with a significance value of 0.807.

The lowest FCR value was obtained in treatment A, while the highest value was obtained in treatment D. ANOVA analysis results showed that the addition of carrot flour had no significant effect on the FCR value of goldfish (P>0.05) with a significance value of 0.987.

The survival percentage of goldfish during the study in each treatment is presented in the following diagram.

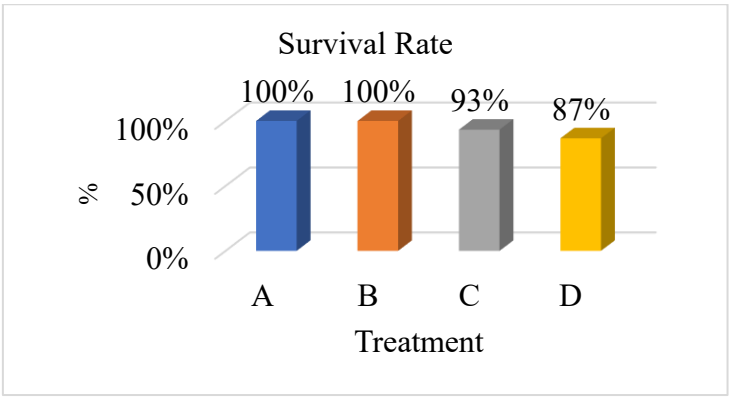

Figure 5. Goldfish Survival Rate Diagram

The highest survival rate was obtained in treatments A and B with a value of 100%, while the lowest was in treatment D at 87%.

The results of water quality measurements during the study are presented in the following table.

Table 3. Results of Water Quality Measurements During the Research

Parameter	Hasil Pengukuran	Kisaran Optimal
Temperature (°C)	27,3–28,0	27–28°C (Duta *et al*., 2025)
pH	7,1–7,8	6,5 - 8,5 (Duta *et al*., 2025)
DO (mg/L)	6,20–6,54	> 5 (Sari *et al*., 2023)
Ammonia (mg/L)	0	0.025 mg/l (Wahyuningsih & Gitarama, 2020)

All water quality parameters during the study were within the optimal range suitable for goldfish maintenance.

DISCUSSION

The results of the study showed that the addition of carrot flour (*Daucus carota*) to commercial feed significantly increased the color brightness of goldfish (*Carassius auratus*), but did not significantly affect the absolute length growth, absolute weight growth, specific growth rate (SGR), or feed conversion ratio (FCR). The highest increase in color brightness was obtained in treatment D (25%), but the results of the Duncan test showed that treatments C (20%) and D (25%) were not significantly different. These findings indicate that the addition of 20% carrot flour has been able to produce an optimal pigmentation response in goldfish.

The increase in color brightness observed in the treatment with the addition of carrot flour is thought to be closely related to the β-carotene content in carrots. β-carotene is a group of carotenoids that act as natural pigments that produce yellow, orange, and red colors in ornamental fish. Carotenoids contained in feed are absorbed through the digestive tract, then transported through the bloodstream and accumulated in chromatophore cells in the skin and scales of fish. This pigment accumulation causes an increase in the intensity of the fish's body color. Because fish are unable to synthesize carotenoids optimally within their bodies, their pigment needs must be met through their diet. Therefore, increasing the dose of carrot flour in this study was followed by an increase in the fish's color brightness.

These results align with those of Jain *et al*. (2019), who reported that supplementing carrot flour in koi feed significantly improved body color quality without disrupting growth performance. Similar results were also reported by Firdaus *et al*. (2022), who found that using carrot flour as a natural carotenoid source gradually increased fish color pigmentation during the rearing period. Furthermore, Dwiastuti *et al*. (2024) also stated that adding carrot flour to commercial feed resulted in the best color enhancement in koi compared to treatments without supplementation. These similar results indicate that carrots are an effective source of β-carotene for enhancing the color quality of various ornamental fish species.

These research findings were further supported by Haetami *et al*. (2020), who reported that administering carrot flour to comet carp fry significantly improved the color quality of the fish. Similarly, Ahlam *et al*. (2019) demonstrated that combining carrot flour with other natural ingredients rich in carotenoids can increase the color intensity of oranda goldfish. Sathyaruban *et al*. (2025) explained that carrots are a natural source of carotenoids widely used in the ornamental fish farming industry due to their high β-carotene content, easy availability, and safe long-term use. In addition to functioning as pigments, Manikandan *et al*. (2020) stated that carotenoids also act as antioxidants, helping maintain cell health and improving the physiological quality of fish.

Although treatment D produced the highest color increase, Duncan's test results showed that the color increase in treatment C (20%) was not significantly different from treatment D (25%). This indicates that the addition of 20% carrot flour produced a color response equivalent

to that of the higher dose. Therefore, the use of 20% carrot flour can be considered an efficient dose for enhancing the color brightness of goldfish.

Unlike the color parameters, the addition of carrot flour had no significant effect on absolute length growth, absolute weight growth, or specific growth rate of goldfish. Although descriptively, there was a tendency for growth to decrease with increasing carrot flour dosage, statistical analysis showed that this difference was not significant. This indicates that carrot flour functions more as a source of natural pigment than as a primary nutrient that plays a direct role in the formation of fish body tissues.

The lack of growth differences between treatments is likely because the fish's nutritional needs were still met by the commercial feed used as the main component in all treatments. These results can be seen from the nutritional characteristics of the feed ingredients used. Prima Feed FP800 commercial feed contains 39–41% protein, 5% fat, 6% crude fiber, 16% ash, and a maximum moisture content of 10%. This high protein content indicates that commercial feed serves as the primary source of nutrients to support fish growth. A study by Setiawan *et al*. (2025) explained that fish growth is greatly influenced by nutritional adequacy, especially protein and energy used for body tissue formation. Feed with adequate protein content allows the growth process to continue even with the addition of non-protein additives in the feed formulation. The results of research by Martini *et al*. (2024) also showed that the quality and composition of feed nutrients are the main factors determining the growth rate and survival of farmed fish. In this study, the still dominant proportion of commercial feed is thought to be able to maintain nutritional adequacy so that fish growth is relatively uniform across all treatments.

These findings align with research by Jain *et al*. (2019) and Firdaus *et al*. (2022), which showed that carrot flour supplementation had a greater effect on increasing pigmentation than on fish growth. A study by Ranjith & Kumar (2025) also explained that the primary function of carotenoids is more related to color formation, antioxidant activity, and improving fish health than increasing body biomass. Therefore, the results of this study confirm that carrot flour is more effective as an additive to improve the visual quality of ornamental fish than as a supplement to enhance growth performance.

The relatively uniform FCR values across all treatments indicate that the addition of carrot flour up to a dose of 25% did not reduce feed utilization efficiency by goldfish. Although there was a trend toward an increase in FCR values at higher doses of carrot flour, the difference was not statistically significant. This indicates that fish were still able to utilize feed with relatively similar efficiency even though some commercial feed was replaced with carrot flour. These results align with the opinion of Martini *et al*. (2024), who stated that feed conversion efficiency is strongly influenced by the nutritional quality of the feed and the ability of the fish to utilize available nutrients. Furthermore, Togatorop *et al*. (2025) explained that fish growth performance and feed efficiency are closely related to the fish's ability to optimize the nutrients contained in the feed consumed. Therefore, the absence of a difference in FCR indicates that the addition of carrot flour up to 25% is still tolerated by the goldfish digestive system.

The survival rate of goldfish during the study was relatively high, ranging from 87–100%. The high survival rate indicates that the use of carrot flour as a feed additive is relatively safe and does not have significant negative impacts on fish health. These results align with research by Margaretha *et al*. (2025), which stated that a high survival rate reflects the fish's successful adaptation to the feed and rearing environment. According to Martini *et al*. (2024), a high survival rate also indicates that the fish's physiological needs during rearing are being met, thus reducing mortality.

The high survival rate in this study is thought to be influenced not only by feed quality but also by water quality conditions, which remained within the optimal range throughout the study. The water temperature ranged from 27.3–28°C, pH 7.1–7.8, dissolved oxygen (DO)

6.20–6.54 mg/L, and ammonia 0 mg/L. This range is still suitable for supporting the life and physiological activity of goldfish. Sari *et al*. (2023) explained that adequate dissolved oxygen availability is crucial for supporting goldfish respiration and metabolism. DO values above 6 mg/L during the study indicate excellent environmental conditions for fish growth and survival.

Furthermore, good water quality was also indicated by the absence of ammonia in the culture medium. Ammonia accumulation in the culture medium can cause physiological stress, reduce fish health, and increase the risk of mortality (Yudiana *et al*., 2022). Therefore, ammonia levels of 0 mg/L indicate that maintenance management and environmental quality were successful during the study. This finding aligns with Rizal *et al*. (2021) stated that stable water quality is an important factor in maintaining the health, growth, and productivity of farmed fish.

CONCLUSION

The addition of carrot flour (*Daucus carota*) to commercial feed effectively increases the color brightness of goldfish (*Carassius auratus*). Color enhancement tends to increase with increasing carrot flour dosage, with a 20% dose producing optimal color enhancement, as it is not significantly different from the 25% dose.

The addition of carrot flour did not significantly affect absolute length growth, absolute weight growth, specific growth rate (SGR), or feed conversion ratio (FCR). Therefore, its use as a natural carotenoid source does not interfere with goldfish growth performance and feed utilization efficiency.

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