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### THE EFFECT OF SUPPLEMENTARY FEEDING WITH CABBAGE (*Brassica oleracea* L.) AT DIFFERENT TIME INTERVALS ON THE GROWTH OF GOURAMI FISH (*Osphronemus goramy*)

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#### ABSTRACT

*The gourami fish (*Osphronemus goramy*) is a native Indonesian freshwater species that has spread throughout Southeast Asia and China. Increasing growth in gourami fish production is directly proportional to the high cost of feed; therefore, efforts to reduce the production cost of gourami fish feed can be made by improving feed combinations that can produce optimal fish growth. This can be achieved by providing supplementary feed in the form of cabbage, which is easy to obtain and affordable, at different time intervals during the grow-out phase of gourami fish. The purpose of this study was to determine the effect of supplementary cabbage feed at different intervals on the growth of gourami fish and to identify the best feeding interval for supplementary cabbage feed. This study used an experimental method with a completely randomized design consisting of four treatments and three replications, with feeding intervals as follows: A (0-day interval), B (1 day), C (2 days), and D (3 days). The test fish used were gourami with an average size of  $8.9 \pm 0.1$  cm and an average weight of  $10.5 \pm 0.24$  grams/fish. The rearing containers for the gourami fish used hapa nets measuring (1x1x1 m). The stocking density per hapa was 30 fish/m<sup>2</sup>, with a rearing period of 42 d. The results showed that providing supplementary cabbage feed at different intervals during the grow-out of gourami fish had a significant effect ( $P < 0.05$ ) on the total feed consumption (TFC) in treatment A (0 days), which resulted in a TFC of  $(511.6 \pm 37.8)$  g, but had no significant effect on the feed conversion ratio (FCR), relative growth rate (RGR), absolute weight and length gain, and survival rate (SR). Water quality was found to be optimal, with temperatures ranging from 21-28.4°C, pH 7-8.5, and DO 2.6-9 mg/L.*

**Keywords:** *cabbage, feed, gourami fish, rearing, time interval*

## INTRODUCTION

The increasing growth of gourami fish production is directly proportional to the high cost of feed; therefore, there has been a shift from using animal-based feed ingredients to plant-based feed ingredients or supplementary feed containing plant-based protein, which is affordable, readily available, and of good quality, so that it can help reduce feed production costs. This is because artificial feed is one of the crucial factors in intensive fish farming, representing the largest variable cost in the production process, amounting to 50%-70% of the total production costs (Babo *et al.*, 2013). Dependence on imported fish feed ingredients has led to high prices (Lestari *et al.*, 2013). Therefore, efforts to reduce the production costs of gourami fish feed (*Osphronemus gouramy*) can be made by improving the combination or supplementation of pellet feed and cabbage, which is expected to result in optimal fish growth.

One of the plant-based feed ingredients that can be used as a supplementary feed for gourami fish is cabbage (*Brassica oleracea* L.). Rukmana (1994) explained that the nutrient and mineral composition contained in every 100 g of cabbage includes calories (25.0 cal), protein (2.4 g), carbohydrates (4.9 g), calcium (22.0 mg), phosphorus (72.0 mg), iron (1.1 mg), vitamin A (90.0 mg), vitamin B1 (0.1 mg), vitamin C (69.0 mg), and water (91.7 g). Research by Marnani and Pramono (2017) on the use of cabbage has been conducted on the prospective broodstock of gourami fish, resulting in an absolute growth of 425 g, a relative growth of 22.1%, and a daily growth of 7.1 g/day. Current efforts in fish farming focus on regulating feed administration so that the feed can be optimally utilized for growth and survival. Proper feed management will provide optimal results for growth, increase feed utilization efficiency by fish, and maintain water quality (Hanief *et al.*, 2014). One method to increase feeding efficiency and accelerate growth is to provide supplementary cabbage feed at different time intervals during the rearing of gourami fish.

## MATERIALS AND METHODS

This research was conducted at the Balai Budidaya Ikan Air Tawar (BBIAT) Ngrajek, Magelang. The materials used in this study were gourami fish with a total length of  $8.9 \pm 0.1$  cm and a weight of  $10.5 \pm 0.24$  grams, and freshwater as the maintenance medium. The feed used in this research was commercial feed of the brand Prima Feed or PF-1000 and cabbage. The equipment used in this research included concrete ponds with muddy sediment as the main container for rearing the fish, 12 hapa nets ( $1 \times 1 \times 1$  m) as fish rearing containers, 20-liter buckets for fish sampling, nets for catching fish, millimeter blocks for measuring fish length, digital scales with 0.01 g precision for measuring fish and feed weight, a Water Quality Checker (WQC) Lutron for measuring DO content and temperature, a pH meter for measuring the water's pH, a device for documentation purposes, and stationery for recording research data.

The experimental design used was an experimental method with a Completely Randomized Design. The treatment applied in this study was variation in the timing or intervals of supplementary feed given as feed for gourami fish. This study consisted of four treatments and three replicates. The treatments used were as follows.

Treatment A: Administration of artificial feed without any time interval (0-day interval).

Treatment B: administration of supplemental cabbage feed with a 1-day interval

Treatment C: administration of supplemental cabbage feed with a 2-day interval

Treatment D: administration of supplemental cabbage feed with a 3-day interval

The procedure for conducting the research is carried out through the following steps,

1) Preparation of the Container

Container preparation was performed to prepare the equipment and materials used in the study. The pond used for maintaining the test fish was drained and then cleaned, after which the hapa was installed. The placement and installation of the hapa in the pond were performed when the water level was approximately 40–60 cm (SNI: 01-6485.3 – 2000).

2) Stocking and Maintenance of Fish

The fish were sourced from fish farmers in the Magelang area. The fish measure  $8.9 \pm 0.1$  cm in length and weigh  $10.5 \pm 0.24$  grams, and were then stocked at a density based on (SNI: 01-6485.3 – 2000), which is 30 fish/m<sup>2</sup> in the research pond with acclimatization or environmental adaptation. The study was conducted over 42 days.

3) Feeding Management

Feeding during the study was carried out using the fixed feeding rate method (feeding based on the percentage weight of the test animals' biomass). The amount of feed given, according to SNI 01-6485.3 – 2000, was 4% of the biomass weight, with a feeding frequency of twice a day at 08:00 and 16:00. The feed consisted of pellets and cabbage that had been cut into small pieces to fit the fish's mouth opening. The cabbage was cut and washed clean beforehand to remove dirt. Cabbage used as feed was cut into pieces of approximately 3-4 cm. The feed was weighed before use as experimental feed. The dosage for feeding the gourami fish was 60% pellets and 40% cabbage, according to Marnani and Pramono (2016). Uneaten feed was collected and left for 1 h to remove any water from the feed. Subsequently, the leftover feed was weighed to determine the amount of feed consumed by the fish.

The parameters observed in this study are as follows:

a. **Total Feed Consumption (TFC)**

Total feed consumption can be calculated using the following formula (Pereira *et al.*, 2007)

$$TFC = F1 - F2$$

Description: F1 = Initial feed amount (g)

F2 = Amount of used feed (g)

b. **Feed Conversion Ratio (FCR)**

The FCR was calculated using the formula by Tacon and Metian (2008) and Selang *et al.* (2020) as follows:

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

Description: F = Feed intake weight (g)

Wt = The biomass of the fish at the end (g)

D = Weight of dead fish (g)

Wo = Biomass of test animals at the beginning of rearing (g).

c. **Absolute Weight Gain**

The absolute weight gain was calculated using the formula by Effendi (2003) and Utami *et al.* (2019) as follows:

$$W = Wt - Wo$$

Description: W = Absolute weight gain (g)

Wt = Average weight of the fish at the end (g)

Wo = Average body weight at the beginning (g)

d. **Absolute Length Growth**

According to Effendi (1997) and Mustofa *et al.* (2018), absolute length growth was calculated based on the following formula:

$$L = L_t - L_0$$

Description: L = Absolute length growth (cm)  
L<sub>t</sub> = The length of the fish at the end (cm)  
L<sub>0</sub> = The length of the fish at the beginning (cm)

**e. Relative Growth Rate**

According to De Silva and Anderson (1995), the relative growth rate (RGR) of fish was calculated using the following formula:

$$RGR = \frac{W_t - W_0}{W_0 \times t} \times 100$$

Description: W<sub>t</sub> = Fish weight at the end (g)  
W<sub>0</sub> = Fish weight at the beginning (g)  
t = rearing period (days)

**f. Survival Rate**

According to Effendi (2003), the Survival Rate (SR) is calculated using the following formula:

$$SR = \frac{N_t}{N_0} \times 100\%$$

Description: N<sub>0</sub> = number of fish at the beginning  
N<sub>t</sub> = number of fish at the end

**g. Water Quality**

Water quality measurements included temperature, pH, and dissolved oxygen (DO). Water quality measurements were performed daily before feeding at 08:00 and 04:00.

**Data Analysis**

The data obtained from the research results, including total feed consumption, absolute weight gain, absolute length, relative growth rate (RGR), feed conversion ratio (FCR), and survival rate (SR), were statistically analyzed using ANOVA (Analysis of Variance) with a 95% confidence interval. Prior to conducting ANOVA, the data were subjected to normality, homogeneity, and additivity tests to determine whether the data were normal, homogeneous, and additive for variance (ANOVA) analysis. If the results of the ANOVA showed a significant difference, a follow-up Duncan's Multiple Range Test was conducted to determine the differences in means between treatments. Water quality parameters were descriptively analyzed by comparing them with those reported in the literature.

**RESULTS AND DISCUSSION**

**a. Total Feed Consumption**

The total feed consumption during the study period is shown in Figure 1.

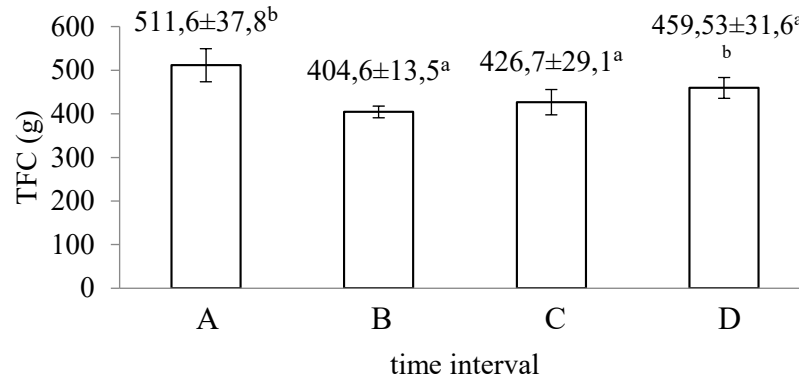


Figure 1. Histogram of Total Feed Consumption

The results of the Analysis of Variance (ANOVA) showed that all treatments had a significant effect on total gourami feed consumption ( $P < 0.05$ ). Based on the results of the observations and calculations of the total feed consumption value of gourami (*O. gouramy*) in this study, there was a significant effect. Treatment A was different from treatments B, C, and D because the treatment using cabbage feed showed the same results, so the FCR values were not significantly different. Feed is a crucial factor for fish growth. Gourami consumed the most cabbage at 25% out of the 40% provided in treatment B, indicating that gourami have a low preference for cabbage but are starting to adapt to cabbage feed. According to Wibowo *et al.* (2024), good feed quality includes appropriate form, size, and nutritional value for fish growth.

Differences in feeding intervals are also important. Treatment B (1-day interval) showed higher cabbage consumption than treatments C and D, indicating that more frequent feeding increases adaptation and consumption. Conversely, in C and D (2–3 day intervals), consumption was lower due to a lack of adaptation to inconsistent feeding. The palatability of cabbage for gourami is low, possibly because of its taste, texture, and nutritional value. Subandiyono and Hastuti (2021) stated that palatability might be related to texture or nutritional components.

Water quality also affects feed consumption, including the preference and palatability of the cabbage. Gourami are sensitive to water quality factors such as pH, temperature, and oxygen levels. According to Usman *et al.* (2022), low temperature and low dissolved oxygen can decrease the feed consumption rates. If the water quality is poor, gourami may feel uncomfortable and tend to avoid less appealing feeds, such as cabbage, even if it is mixed with pellets. Poor water conditions can reduce fish activity and appetite, making them more likely to consume readily accepted feeds, such as pellets.

#### b. Feed Conversion Ratio

Based on the feed conversion ratio data for gourami (*O. gouramy*) fry during the study, a histogram was created, as shown in Figure 2.

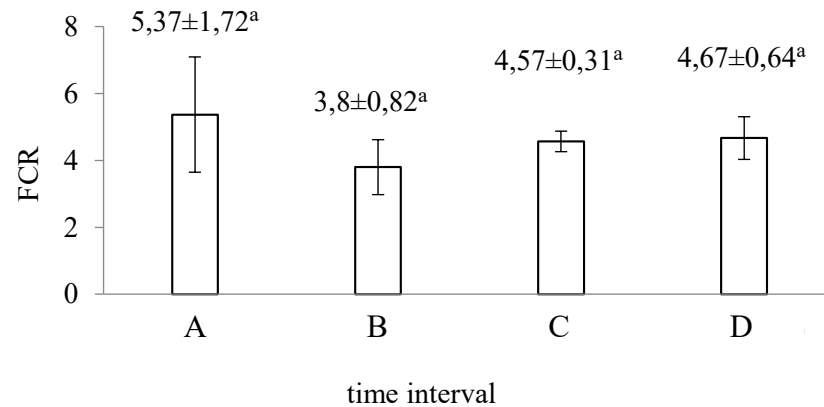


Figure 2. Histogram of Feed Conversion Ratio for Gourami Fish (*O. gouramy*)

The results of the Analysis of Variance (ANOVA) showed that none of the treatments had a significant effect on the feed conversion ratio of gourami fish ( $P > 0.05$ ). The FCR value of gourami fish fed supplementary feed in the form of cabbage showed a fairly high conversion rate. Putra's (2017) research indicated that feed conversion using water spinach leaves mixed into pellets for tilapia has a relatively high FCR (4.86–7.81). According to Mudjiman (1989) and Akbar *et al.* (2011), FCR values range from 1.5 to 8 depending on the type of feed provided, and plant-based feeds generally have higher conversion rates than animal-based feeds.

According to Marnani and Pramono (2016), cabbage contains 8.53% water, 5.05% ash, 28.42% protein, 9.05% fat, and 48.95% carbohydrate. According to Sugara & Ryanto (2020), the crude fiber content of cabbage is 12.09%. This nutritional content can decrease feed efficiency, and fish consume only a limited amount of cabbage. However, in treatment B, gourami fish began to utilize nutrients from cabbage, although the efficiency was still low. Marnani and Pramono (2016) explained that feed is determined not only by protein but also by other nutrients, such as fats, vitamins, minerals, and carbohydrates, which can substitute the energy derived from protein. According to Mokoginta and Subandiono (2005), carbohydrates can serve as an alternative energy source, replacing part of the energy from proteins for growth.

The highest FCR value was observed in Treatment A (0-day interval). This is likely due to uneven feed distribution. Sluggish and individual gourami may be dominated by others, resulting in some fish not receiving feed, even though the amount provided is recorded as consumption. This causes feed wastage and increases the FCR. According to Rahman *et al.* (2023), imbalances in feed distribution reduce feed utilization efficiency.

Water quality also greatly influences the FCR. When fish die because of water pollution, the feed consumed is not optimally converted. According to Hanief *et al.* (2014), feed must be given in the right amount: too little will slow growth, too much causes inefficient metabolism, and pollutes water. The correct feeding frequency is essential for increasing the feed efficiency. In line with Maloho *et al.* (2016), high daily feed consumption indicated lower efficiency in utilizing feed for growth.

### c. Absolute Weight Gain

Based on the initial and final weight measurements of the gourami fish taken at the beginning and end of the 42-day rearing period, data on the absolute weight gain of the gourami fish were obtained, and all these values can be represented in a histogram, as shown in Figure 3.

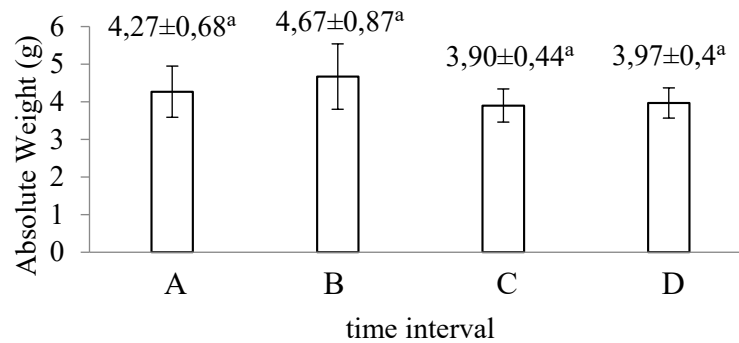


Figure 3. Histogram of Absolute Weight Gain of Gourami Fish

The results of variance analysis (ANOVA) showed that none of the treatments had a significant effect on the absolute weight gain of gourami during the study ( $P>0.05$ ). The provision of supplementary feed in the form of cabbage at different feeding intervals did not have a significant effect on the absolute weight gain of gourami fish because of their low preference and palatability for cabbage. Feeding cabbage at various intervals also consistently showed that gourami consumed only a small amount of cabbage, resulting in suboptimal feed intake. The absolute weight of the fish will only increase if the feed provided is of good quality and is utilized for somatic growth (muscle and flesh tissue), which was observed only during the 42 days of research. According to Marnani and Pramono (2016), feed factors play a crucial role in determining both somatic and gonadal fish growth.

The weight growth of fish in Treatment B, with a one-day interval, showed that the fish began to adapt and make use of the cabbage. Routine supplementation can provide positive stimuli for fish metabolism and growth. In addition, Mulyadi *et al.* (2010); Hanief *et al.* (2014) found that inappropriate feeding times can affect the life of fish.

In treatments with 2–3 day intervals, the fish received the mixed feed only occasionally, not giving them enough time to adapt, causing the fish to be selective or ignore the cabbage. The amount of cabbage consumed was also lower, indicating that the nutritional contribution of cabbage was not optimal. According to Firmansyah *et al.* (2021), the weight of gourami increases over the maintenance period, highlighting the importance of feed availability in the rearing tank, which is expected to be utilized by fish for growth.

#### d. Absolute Length Growth

The value of absolute length growth in this study can be illustrated in a histogram, as shown in Figure 4.

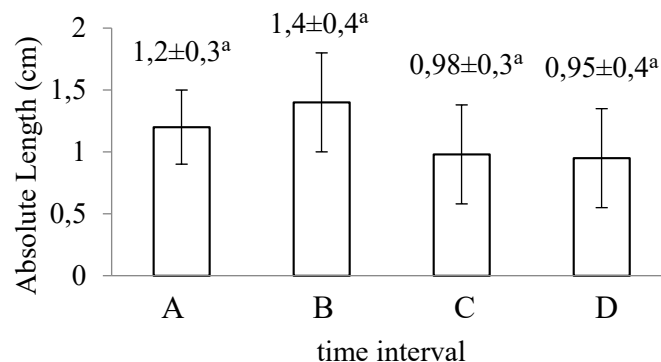


Figure 4. Histogram of Absolute Length Growth of Gourami Fish

The results of variance analysis (ANOVA) showed that all treatments had no significant effect on the absolute length growth of gourami during the study ( $P>0.05$ ). The absolute length growth values during the study showed results consistent with absolute weight growth; namely, there was no significant difference between treatments ( $p>0.05$ ). This indicates that the differences in the feeding interval treatments did not have a significant effect on the growth rate of gourami. According to Firmansyah *et al.* (2021), growth in length is generally proportional to the increase in fish weight, although this may vary depending on the quality and frequency of feeding.

The intervals of supplemental cabbage feeding are suspected to also biologically affect the results of absolute length growth, although they were not statistically significant. The combination of cabbage and pellets within certain time intervals has the potential to influence digestion efficiency and nutrient absorption, especially fiber and vitamins from cabbage, which contribute to the formation of body tissues, such as bone and muscle. However, the effects of this supplemental feed are not always immediately apparent, because length growth tends to progress more slowly and linearly. According to Prasetyo *et al.* (2020), length growth is positive growth that continues to increase over time, whereas weight growth can fluctuate depending on physiological conditions and feed availability.

During the 42-day rearing period, the fish experienced natural length growth due to the growth of somatic cells, such as bones and muscles, and development of the nervous system. According to Yustiati and Asiah (2018), fish growth involves the growth of somatic cells that affect the body dimensions.

#### e. Relative Growth Rate

Based on the measurements of the initial and final weights of the gourami fish taken at the beginning and end of the 42-day rearing period, data on the relative growth rate of the gourami were obtained, with all values depicted in a histogram, as shown in Figure 5.

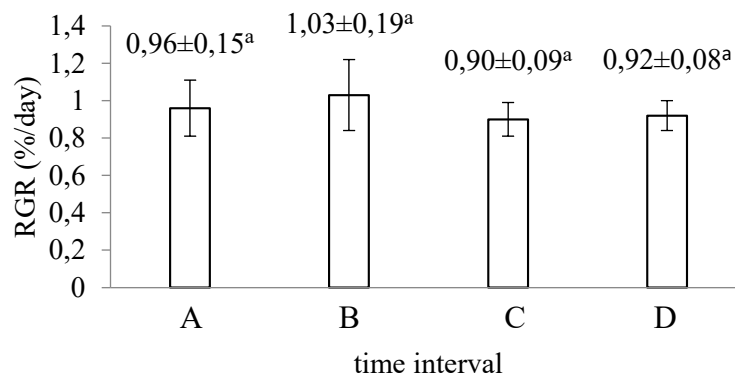


Figure 5. Histogram of the Relative Growth Rate of Gourami Fish

The results of variance analysis (ANOVA) showed that all treatments had no significant effect on the relative growth rate of gourami during the study ( $P>0.05$ ). The results showed that the addition of supplementary feed in the form of cabbage and pellets to the diet of the gourami fish (*O. gouramy*) did not have a significant effect on the relative weight growth rate. This may be due to differences in feeding intervals, and the nutritional needs of gourami fish not being fully met by the combined feed of pellets and cabbage. Pellets are rich in nutrients for optimal growth (Tacon and Metian, 2008), and cabbage, as an additional plant-based feed, may also influence the growth rate of fish (Riche *et al.*, 2004).

Treatment B (60% pellets and 40% cabbage daily) resulted in a higher RGR value, but the effect was not significant, indicating that consistent cabbage supplementation still had a limited impact on increasing the relative growth rate. This is likely because cabbage's



contribution as a supplementary feed is not substantial enough to optimally enhance fish growth. According to Martati *et al.* (2020), the use of cabbage vegetable waste in artificial feed had a significant effect on the specific growth rate of patin djambal fish, with the best results observed with a 40% mix of mustard greens and cabbage.

In Treatments C and D (with 2- and 3-day intervals), the main nutrient intake from pellets remained consistent, but the irregular provision of cabbage did not provide a consistent feeding stimulus, so it did not have a significant impact on growth. According to Turker (2006), less frequent feeding intervals decrease growth rates because of suboptimal nutrient availability. Additionally, the relatively small amount of cabbage consumed also limits the nutritional contribution of the supplementary feed.

The relative growth rate not only affects the 42-day period but can also be predictive over a longer term. The similar values in each treatment indicated that the growth of gourami fish was relatively slow. According to Nirmala and Rasmawan (2010), slow growth is a challenge in gourami fish farming, resulting in a longer time required to reach the desired size.

#### f. Survival Rate

Based on the initial and final measurements of the number of gourami fish taken at the beginning and end of the 42-day rearing period, data on the survival rate of gourami fish were obtained. Survival rates are shown in Figure 6.

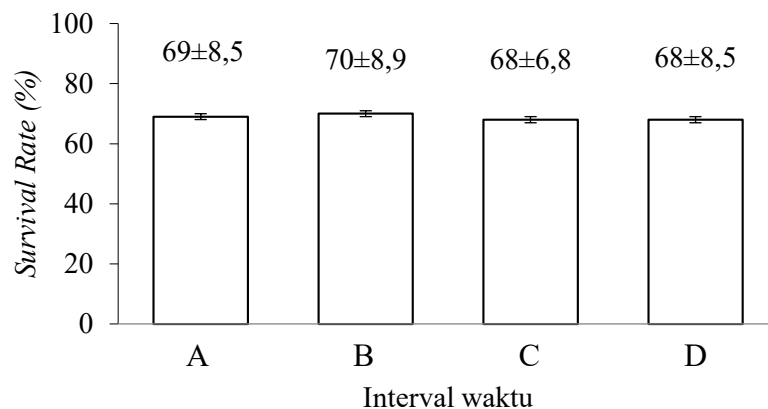


Figure 6. Survival Rate Histogram of Gourami Fish

The results of the analysis of variance (ANOVA) showed that all treatments had no significant effect on the survival of gourami fish during the study ( $P>0.05$ ). The results of water quality analysis showed temperatures of 21–28.4°C, pH of 7–8.5, and DO of 2.6–9 mg/L, which are ideal for gourami fish farming; however, the survival rate only reached 68%–70%. This could have been caused by fluctuations in DO, leading to stress and decreased fish immunity. According to Usman *et al.* (2022), decreased dissolved oxygen levels in water can cause stress, fainting, or even mass mortality. Khalil (2015) stated that gourami are highly sensitive to sudden temperature changes, which can cause stress or even death.

Cabbage, as a supplementary feed, contains fiber and vitamins C and K, but its protein and energy content are lower than those of pellets. According to Mainisa (2021), fish require 35–50% protein and 4–18% fat. Cabbage contained 28.42% protein and 9.05% fat, whereas pellets contained 39–41% protein and 5% fat. Therefore, cabbage is more suitable as a supplementary feed than as the main feed.

Treatments at different time intervals caused the role of cabbage in the fish body to be inconsistent. With a 1-day interval, cabbage intake was higher, but overall consumption

remained low because gouramis are not pure herbivores, resulting in low nutrient absorption. The survival rate did not increase significantly because cabbage did not have a strong protective effect on fish health. At intervals of 2 or 3 days, the feeding stimulus from cabbage decreased, and the intake of micronutrients, such as antioxidants, also decreased, so its biological benefits were not consistent. According to Riche *et al.* (2004), limited consumption at low frequencies means that fish do not get enough protein and energy for growth and survival.

Treatment A (100% pellets daily) resulted in a survival rate similar to that of other treatments, showing that pellets already met the basic nutritional and energy requirements. According to Virnanto *et al.* (2016), the energy in the feed derived from non-protein sources can affect the amount of protein used for growth. The feed lacks energy from non-protein sources, most of the proteins that should be used for growth will be utilized as an energy source or for cell maintenance. Conversely, if the energy in the feed is high, this can limit the amount of feed consumed by the fish, which in turn limits the amount of protein consumed, resulting in lower growth.

Supplementation with cabbage feed at different intervals had no significant effect ( $P>0.05$ ) on the survival rate of gourami. The less-than-optimal survival rate is suspected to be because the fish were not yet able to adapt well to the environment and feed; therefore, the energy required for activity, growth, and survival was not optimally utilized. According to Mulyani *et al.* (2014), fish survival is highly dependent on adaptability to feed and the environment, fish health status, stocking density, and water quality.

## Water Quality

The results of water quality measurements during the study are shown in Table 7.

Table 7. Water Quality Values During the Research

Parameter	Treatment				Optimum range
	A	B	C	D	
Temperature ( $^{\circ}\text{C}$ )	21-28,4	21-28,4	21-28,4	21-28,4	25-30 <sup>a</sup>
pH	7 – 8,5	7 – 8,5	7 – 8,5	7 – 8,5	6,5-8,5 <sup>a</sup>
Dissolved Oxygen(mg/L)	2,6-9	2,6-9	2,6-9	2,9-8	2 <sup>b</sup>

Source : a. SNI : 01- 6485.3 – 2000; b. SNI : 01- 7241 – 2006

The temperature observations during the research showed a range of 21–28.4°C. During the study, there were instances where the temperature was less than optimal for the cultivation of gourami fish, particularly when it dropped to 21°C. According to the SNI: 01-6485.3–2000, the suitable temperature range is 25–30°C. The survival of fish can be directly affected by temperature. Water temperatures that cannot be tolerated by fish, or when temperatures fall outside the optimal minimum and maximum limits, can cause fish to die. Fish can also die if there is a sudden change in temperature (Boyd, 1979; Nurhuda *et al.*, 2018).

The pH of the rearing medium ranged from 7 to 8.5. According to the SNI: 01-6485.3–2000, the optimal pH for gourami is 6.5–8.5. The pH values remained within the normal range. Abnormal pH levels can affect the growth or even result in the death of aquatic organisms. This is supported by Nirmala *et al.* (2012), who stated that lethal pH levels for fish are below 4 and above 11, while at pH levels below 6.5 and above 9.5, growth and reproduction may be affected within a few hours.

Dissolved oxygen (DO) is an important variable in determining water quality. The results of dissolved oxygen measurements during cultivation ranged from 2.6–9 mg/L. According to SNI: 01-7241–2006, the optimal dissolved oxygen range for gourami was 2

mg/L. Rudiyanti and Astri (2009) reported that a minimum oxygen level of 2 mg/L in water is adequate to support aquatic organisms under normal conditions.

## CONCLUSION AND SUGGESTIONS

Based on the research conducted, it can be concluded that:

1. The provision of supplemental cabbage feed (*Brassica oleracea* L.) at different time intervals for the growth of gourami fish (*O. gouramy*) had a significant effect only on total feed consumption but did not have a significant effect on feed conversion ratio, absolute length, absolute weight, relative growth rate, and survival rate.
2. There was no treatment that yielded the best results in providing supplemental cabbage feed at intervals of 1, 2, and 3 days for the growth of gourami fish.

The suggestions for this research are as follows:

1. Further research should be conducted on supplementary feeding with different feeding intervals to improve the growth of gourami fish.
2. Further research should be carried out in indoor cultivation media or containers using different plant-based or supplementary feed ingredients to optimally support the growth of gourami fish..

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