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# The Effectiveness of the Biofloc System Cultivation with the Addition of Supplements Ginger Flour through Feed on the Growth of Tilapia

## Efektivitas Budidaya Sistem Bioflok dengan Penambahan Suplemen Tepung Jahe melalui Pakan terhadap Pertumbuhan Ikan Nila

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**Abstract:** *The demand for tilapia consumption cannot be fulfilled due to limited availability. To overcome this, intensive cultivation is carried out by increasing the stocking density. An increase in stocking density can lead to a decrease in water quality which in turn can inhibit growth. To overcome this problem, biofloc system cultivation is carried out with the addition of herbal supplements through feed so that water quality is maintained and fish growth is optimal. This study aims to determine the effectiveness of the ginger diet on the growth of tilapia reared for 60 days compared to the ginger and garlic diet for 90 days with biofloc system cultivation.The study was conducted by the experimental method using a completely randomized design, with 3 treatments, and 1 control, and each was repeated 4 times for 60 days. The results showed that cultivating tilapia using the biofloc system with the ginger diet for 60 days significantly increased growth, while the garlic diet for 90 days was only significant for weight gain. A ginger diet for 60 days on tilapia and 90 days on gourami with a biofloc cultivation system has the same pattern and effectiveness on growth with an optimal dose of 5.63 g kg-1 feed. The cultivation of the biofloc system was more effective with the ginger diet for 60 days compared to the ginger and garlic diet for 90 days on fish growth. This shows that biofloc cultivation for 60 days with a ginger diet is recommended for fish farming.*

**Keywords:** Biofloc, ginger, garlic, growth, tilapia.

**Abstrak:** *Permintaan ikan nila untuk konsumsi tidak dapat dipenuhi karena ketersediaan yang terbatas. Untuk mengatasinya, dilakukan budidaya secara intensif dengan meningkatkan padat tebar. Peningkatan padat tebar dapat menyebabkan penurunan kualitas air yang pada akhirnya dapat menghambat pertumbuhan. Untuk mengatasi hal tersebut dilakukan budidaya sistem bioflok dengan penambahan suplemen herbal melalui pakan agar kualitas air tetap terjaga dan pertumbuhan ikan menjadi optimal. Penelitian ini bertujuan untuk mengetahui efektivitas pemberian pakan jahe terhadap pertumbuhan ikan nila yang dipelihara selama 60 hari dibandingkan dengan pemberian pakan jahe dan bawang putih selama 90 hari dengan budidaya sistem bioflok Penelitian ini dilakukan dengan metode eksperimental menggunakan Rancangan Acak Lengkap (RAL), dengan 3 perlakuan dan 1 kontrol, masing-masing diulang sebanyak 4 kali selama 60 hari. Hasil penelitian menunjukkan bahwa budidaya ikan nila dengan sistem bioflok dengan pemberian pakan jahe selama 60 hari secara signifikan meningkatkan pertumbuhan, sedangkan pemberian pakan bawang putih selama 90 hari hanya signifikan terhadap pertambahan berat. Pemberian pakan jahe selama 60 hari pada ikan nila dan 90 hari pada ikan gurami dengan sistem budidaya bioflok memiliki pola dan efektifitas yang sama terhadap pertumbuhan dengan dosis optimal 5,63 g kg-1 pakan. Budidaya sistem bioflok lebih efektif*



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*dengan pemberian pakan jahe selama 60 hari dibandingkan dengan pemberian pakan jahe dan bawang putih selama 90 hari terhadap pertumbuhan ikan. Hal ini menunjukkan bahwa budidaya sistem bioflok selama 60 hari dengan diet jahe direkomendasikan untuk budidaya ikan.*

**Kata Kunci:** Bioflok, jahe, bawang putih, pertumbuhan, ikan nila.

## Introduction

Tilapia is a freshwater fish that is widely consumed by the public. The need for tilapia continues to increase along with awareness of the consumption of protein derived from fish. Therefore, tilapia cultivation continues to be improved through high stocking densities. High stocking densities are generally followed by additional antibiotics so that growth is maintained. However, the use of antibiotics can cause resistance, environmental pollution, and antibiotic deposits in fish bodies. To overcome this, the use of herbal supplements is now widely used. This is because herbal supplements have advantages over drugs or antibiotics, including being safe to use, and not causing resistance, residue deposits, or environmental pollution.

Several research reports show the use of various herbs for fisheries such as ginger, garlic, onion, and others. Ginger is a growth promoter rather than an immunostimulant even though it is immunomodulatory (Sukumaran et al., 2016). In principle, other plants are the same and have various bioactivities, but usually, some are more dominant. Research results prove the addition of ginger flour through feed (ginger diet) can increase weight gain, specific growth rate, feed conversion ratio, and increase feed efficiency. Besides growth, a ginger diet strengthens immunity by increasing the total number of leukocytes, lymphocytes, monocytes, and neutrophils. The ginger diet can also increase antioxidant activity which is indicated by increased SOD and CAT (Naliato et al., 2021). Besides ginger, garlic is widely used in the fisheries industry. Garlic is known to increase growth, but garlic is also antiviral, antibacterial, and immunomodulatory (Valenzuela-Gutiérrez et al., 2021).

Fish cultivators in Indonesia generally have low incomes. Some fish cultivators really hope to benefit from the results of their cultivation. Fast growth, high biomass weight, and survival rate are the hopes of farmers. However, fish and shrimp farming are not always profitable. The alternative is to provide ginger and garlic herbal supplements which are given through feed. To support success, water quality must be maintained properly so that growth can be positive by applying the biofloc cultivation system. The biofloc system is used to improve and maintain good water quality so as to increase feed efficiency and reduce



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feed conversion. Biofloc works by converting inorganic nitrogen, especially ammonia, by heterotrophic bacteria into microbial biomass which is then consumed by fish and shrimp as a feed additive (Ekasari, 2009). In addition to using the biofloc system or technology, additional herbal supplements through feed (herbal diet) so that its growth is more optimal. Previous research has proven that the ginger flour diet (ginger diet) can increase growth by 9.60 g with an optimal dose (DO) of 7.50 g kg-1 feed for 60 days of study (Purbomartono et al., 2021). As a comparison, for 60 days the research results in garlic supplements only reach weight gain of 8,63 g in tilapia with the optimum dose is 30 g kg-1 feed for 28 days (Lengka et al., 2013). A similar study using a biofloc system was reported by (Rijal et al., 2021) showed, feeding garlic flour (Allium sativum) through feed (garlic diet) with the biofloc system can significantly increase the growth of tilapia (O. niloticus) in weight gain of 9,66 g (WG) higher than without biofloc system 4,73 g with optimum dose 40 g kg-1 feed (Purbomartono et al., 2022). Biofloc is proven to increase the growth and production of tilapia (Sukardi et al., 2018). However, little data shows the combination of treatments to boost growth with a longer maintenance time. The combination of cultivation with the biofloc system and the addition of herbal supplements through feed (diet) for 90 days is expected to produce better growth.

To achieve optimal growth in tilapia aquaculture, a combination of treatments is required. The combination of treatment on the cultivation of the biofloc system with the addition of supplements is still relatively limited. Therefore, this study aims to determine the effectiveness of the ginger diet on the growth of tilapia reared for 60 days compared to the ginger and garlic diet for 90 days with biofloc system cultivation. This research used the dosage of ginger supplements was 75%, 50%, and 25% of the optimal dose (OD), because the use of a 100% ginger diet has previously been reported to increase significantly the growth of goldfish (Lamin et al., 2018), and tilapia (Payung and Manoppo, 2015). The results of this study are expected to increase the growth of tilapia, maintain water quality, and increase productivity, and the healthier quality of organic fish.

**Methods**

This section Material

This study used tilapia (7-9 cm), herbal ginger for supplement and the materials for biofloc. Materials for biofloc systems consist of probiotic Effective Microorganisms 4 (EM4), molasses, and salt. The ginger supplement dose for the treatment based on the results of previous studies, is 7.5 g kg-1 feed (Purbomartono et al., 2021).


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*Experimental design*

Experiments were used as the method of this study, using a completely randomized design with 3 treatments and 1 control, each with 3 replications. This study used 2 combinations, consisting of cultivation with a biofloc system and the addition of ginger flour supplements through feed (ginger diet). The ginger supplements used were 75%, 50%, and 25% of the optimal dose (OD), because previously the use of a ginger diet (100%) can increase the growth of goldfish (Lamin et al., 2018), and tilapia (Payung and Manoppo, 2015). While biofloc has been shown to increase the growth and production of tilapia (Sukardi et al., 2018).

This study used tilapia which was given by the addition of ginger supplements which was given through feed (ginger diet). The full treatment is: T0: biofloc (control); T1: biofloc + pellet feed + ginger flour 5.63 (g kg-1 feed) (75% OD); T2: biofloc + pellet feed + ginger flour 3.75 (g kg-1 feed) (50% OD); T3: biofloc + pellet feed + ginger flour 1.88 (g kg-1 feed) (25% OD)

*Growth parameter*

Measurements of growth consist of weight (WG) gain, length gain (LG), and specific growth rate (SGR) followed by Zonneveld et al. (1991):

$$WG = Wt - Wo$$

Where: $WG$ is weight gain (g), $Wt$ is final weight (g), and $Wo$ is initial weight (g).

$$LG = Lt - Lo$$

Where: $LG$ is length gain (cm), $Lt$ is final length (cm), and $Lo$ is initial length (cm).

$$SGR = \left(\frac{\ln Wt - \ln Wo}{t}\right) 100\%$$

Where: $SGR$ is survival growth rate (%), $t$ is research time.

For feed conversion ratio ($FCR$) and feed efficiency ($FE$):

$$FE = \left(\frac{Wt - Wo}{F}\right) 100\%$$

Where: $FE$ = feed efficiency (%), $F$ is total feed consumption (g).

$$FCR = (Wt + D) - Wo$$

Where: $FCR$ = feed conversion rate

*Analysis data*

Data were analyzed using Analysis of variance (ANOVA) at a 95% confidence level using the SPSS program. If there is a significant treatment, then proceed with the Duncan Multiple Range Test (DMRT).



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## Results

The results of research on the ginger diet with the biofloc system on tilapia for 60 and 90 days and the garlic diet for 90 days resulted in significant WG growth. Observed WG parameter data can be seen in Table 1.

*Feed conversion rate* (*FCR*)

On the FCR indicator, the ginger diet for 60 days and the garlic diet for 90 days had almost the same FCR values. However, the garlic diet for 90 days was not significant to FCR compared to the ginger diet for 60 and 90 days which was significant to FCR. In terms of FCR, it shows that the ginger diet for 90 days is better than 60 days (Table 2). Similar to FCR, the ginger diet for 60 and 90 days resulted in significant FE but not significant on the garlic diet for 90 days (Table 3). Based on the data from this study, feed use efficiency (FE) is more optimal on the 60-day ginger diet compared to the 90-day ginger and garlic diet.

Table 1. Weight gain of tilapia fed ginger diet for 60 days and garlic diet and ginger for 90 days.

| Treatment | *Biofloc system* | | |
|---|---|---|---|
| | WG Tilapia | | WG Gourami** |
| | Diet ginger for 60 days | Diet garlic 90 days* | Diet ginger for 90 days |
| T0 | 11,058±0,229$^{a}$ | 9.57±0,32$^{b}$ | 7,19 ± 0,68$^{a}$ |
| T1 | 13,440±0,115$^{d}$ | 9,13±0,09$^{a}$ | 9,42 ± 0,39$^{b}$ |
| T2 | 12,758±0,245$^{c}$ | 9,14±0,16$^{a}$ | 9,02 ± 0,60$^{b}$ |
| T3 | 12,533±0,856$^{c}$ | 9,66±0,21$^{b}$ | 9,20 ± 0,20$^{b}$ |

Description: T0 (Control), T1 (pellet feed + ginger flour 5.63 g), T2 (pellet feed + ginger flour 3.75 g), T3 (pellet feed + ginger flour 1.88 g). Different superscripts in the same column show that there are significant differences ($p < 0.05$). *Rijal et al. (2021); **Purbomartono et al. (2022).

Table 2. Feed conversion rate of tilapia fed ginger diet for 60 days and garlic diet and ginger for 90 days.

| Treatment | FCR Tilapia | | FCR Gourami** |
|---|---|---|---|
| | Diet ginger for 60 days | Diet garlic 90 days* | Diet ginger for 90 days |
| T0 | 6,55±0,21$^{c}$ | 4,22±0,12$^{a}$ | 4,82±0,22$^{b}$ |
| T1 | 4,38±0,75$^{a}$ | 4,36±0,03$^{a}$ | 3,87±0,12$^{a}$ |
| T2 | 4,87±0,03$^{a}$ | 4,37±0,06$^{a}$ | 3,98±0,23$^{a}$ |
| T3 | 5,30±0,40$^{a}$ | 4,29±0,08$^{ab}$ | 3,94±0,11$^{b}$ |

Description: T0 (Control), T1 (pellet feed + ginger flour 5.63 g), T2 (pellet feed + ginger flour 3.75 g), T3 (pellet feed + ginger flour 1.88 g). Different superscripts in the same column show that there are significant differences ($p < 0.05$). *Rijal *et al.* (2021); **Purbomartono *et al.* (2022)

Feed Efficiency (FE)

Table 3. Feed Efficiency of tilapia fed ginger diet for 60 days and garlic diet and ginger for 90 days.

| Treatment | FE Tilapia | | FE Gourami** |
|---|---|---|---|
| | Diet ginger for 60 days | Diet garlic 90 days* | Diet ginger for 90 days |
| T0 | 17,78±0,37$^{a}$ | 23,73±0,71$^{ab}$ | 20,85 ±1,72$^{a}$ |
| T1 | 30,63±4,80$^{b}$ | 22,94±0,17$^{a}$ | 25,84±0,93$^{b}$ |
| T2 | 20,46±0,14$^{b}$ | 22,87±0,34$^{a}$ | 25,16 ± 1,46$^{b}$ |
| T3 | 20,10±0,37$^{b}$ | 23,30±0,44$^{a}$ | 25,41±0,72$^{b}$ |

Description: T0 (Control), T1 (pellet feed + ginger flour 5.63 g), T2 (pellet feed + ginger flour 3.75 g), T3 (pellet feed + ginger flour 1.88 g). Different superscripts in the same column shows that there are significant differences ($p < 0.05$). *Rijal *et al.* (2021); **Purbomartono *et al.* (2022)



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**Discussion**

Based on Table 1, the ginger diet for 60 days was still better for growth than the garlic diet which was maintained for 90 days with the biofloc system on the growth of tilapia. Even though the fish were different, the 60-day ginger diet (in tilapia) was still better than the 90-day ginger diet (in gourami) for growth which was maintained with the biofloc system. This is a comparison, finding, or preliminary assumption, that giving ginger herbal diet can be done in a shorter time depending on the characteristics of the type of herb and the content of its bioactive compounds. So that it is necessary to develop research for other types of herbs so that they better understand the characteristics of each herb such as dosage, length of time for administration, and method of application.

Ginger contains zingiberene and terpene compounds which produce the characteristic odor and taste of ginger (Jolad et al., 2004). These characteristics of smell and taste can stimulate fish appetite so that feed intake increases. Increased appetite can improve fish growth as indicated by increased weight gain, final weight, relative weight gain, specific growth rate and efficiency, and feed conversion ratio. According to (Stoilova et al., 2007), ginger is known as a stimulator of digestive enzyme secretion which can increase feed efficiency and growth performance in *Macrobrachium rosenbergii* shrimp (El-Desouky et al., 2012).

The ginger diet of 10-30 g kg-1 feed in zebrafish was able to increase the activity of the amylase enzyme (Ahmadifar et al., 2019), indicating that growth performance was responsive to the dose of adding dietary supplements containing ginger. Furthermore, supplementation with 10 g of ginger flour kg-1 feed in tilapia (El-Sebai et al., 2018) has a positive effect on growth, in trout (*Oncorhynchus mykiss*) at doses of 1-10 g kg-1 feed, and for white shrimp (*Litopenaeus vannamei*) 5 mg zingerone kg-1 feed (Chang et al., 2012). Based on the results of this study, the ginger diet was more effective for 60 days than 90 days for tilapia and gourami, the cause cannot be explained with certainty. However, reports from (Naliato et al., 2021), a ginger supplementation diet at the highest levels showed detrimental effects, along with decreased hematological values, and production of H2O2, NO, SOD, and lysozyme activity. Therefore, it is recommended to administer immunostimulants, in this case, ginger powder, considering the dose and duration of administration. Giving ginger flour immunostimulants through feed with high doses and/or

long periods of time can cause immunosuppression which results in decreased growth (Sukumaran et al., 2016).

In contrast to the ginger diet, the garlic diet for 90 days also could not match the growth of tilapia on the ginger diet for 60 days. This is presumably because garlic is more immunomodulatory than growth promoters. As reported by (Foysal et al., 2019), garlic contains bioactive compounds that increase fish immunity against attack by disease agents. In fish farming, garlic is antibacterial, antiparasitic, antioxidant, immunomodulatory, and growth stimulator (Bender-Bojalil and Bárcenas-Pozos, 2013). It was further explained, to accelerate the immune response, improvement of resistance to certain pathogens can be done by giving garlic extract, raw garlic, and certain parts of the ginger plant (Foysal et al., 2019).

Based on the research results listed in Table 2, these results raise the notion that FCR is related to the time of fish rearing. FCR shows the amount of feed needed to increase the weight of 1 kg of fish biomass. To increase the weight of 1 kg of tilapia biomass in this study, a smaller amount of feed was needed in the longer rearing period (90 days) compared to the shorter time (60 days). The results of research conducted by (Jolad et al., 2004), showed that ginger has distinctive smell and taste characteristics that affect the increase in feed intake and feed conversion ratio. Apart from being an attractant (appetite stimulator), ginger is known to increase the activity of digestive enzymes. Described by (Ahmadifar et al., 2019), zebrafish fed a ginger diet of 10-30 g kg-1 feed could increase the activity of the amylase enzyme but had no effect on the specific growth rate.

Giving the ginger diet in this study caused the activity of the amylase enzyme which breaks down complex carbohydrate compounds into sugar to increase. The increase in the breakdown of carbohydrates into sugar due to the amylase enzyme causes an increase in the efficiency of food digestion in the digestive tract of fish. Efficiency in food digestion causes intake and the amount of food needed to decrease by increasing the biomass weight of 1 kg of fish so that the FCR becomes low. This low FCR is more indicative of the performance of digestive enzymes so that the digestibility is better but does not automatically increase the significance of the growth of tilapia. This is because fish growth is influenced by the quantity and quality of food and the environment. Fish and animals convert organic matter into live biomass, but the effectiveness is influenced by the quality

and amount of feed and the environment. The changing environment can affect the type and quality of feed which can affect the growth, behavior, and physiology of fish (Jobling, 2008). Research reports prove that herbs derived from plants can act as a stimulator of digestive enzyme secretion (Stoilova et al., 2007), which affects increased feed efficiency and growth performance in *Macrobrachium rosenbergii* shrimp (El-Desouky et al., 2012). Ginger is an herbal plant that can stimulate the secretion of digestive enzymes in the digestive tract. Apart from being a stimulator of digestive enzymes, ginger is also an attractant which can improve response to food intake, feed efficiency, and better growth performance (Naliato et al., 2021). Reinforced by (Jolad et al., 2004), that dietary ginger supplementation has distinctive odor and taste characteristics which affect the increase in efficiency feed intake and feed conversion ratio, increase final weight, relative weight gain, specific growth rate and protein efficiency rate.

The use of ginger herbal diet at a dose of 0.8% (8 g kg-1 feed) in koi fish can increase the efficiency of feeding which has an impact on improving growth and production performance. Further explained, the results of research on adding ginger supplements to the feed (ginger diet) can increase the utilization of nutrients as indicated by the increase in body weight, specific growth rate (SGR), protein efficiency ratio (PER), and feed efficiency (FE) (Lamin et al., 2018). In addition to fish, research results on shrimp also show that a combination of ginger *Z. officinalis* and *C. dactylon* supplements can be used as an appetizer, growth booster and immunostimulant so that it effectively increases growth and immunity in *M. rosenbergii* (El-Desouky et al., 2012).

The results of other studies also prove that ginger flour and essential oil can be used as a dietary feed that is anti-inflammatory, antioxidant and growth-promoting (Brum et al., 2017); Sukumaran et al., 2016). Ginger flour supplementation diet in rainbow trout (Oncorhynchus mykiss) at a dose of 5 g kg-1 feed resulted in growth performance and fish resistance to *Aeromonas hydrophila* infection (Nya and Austin, 2009), while a dose of 10 g kg-1 feed resulted in significant resistance (Haghighi and Rohani, 2013).

**Conclusion**

Cultivating tilapia using the biofloc system with ginger diet for 60 days can significantly increase weight gain, FCR and FE, while the garlic diet for 90 days is only significant for weight gain. Ginger diet for 60 days on tilapia and 90 days on gourami with biofloc cultivation system has the same pattern and effectiveness on growth with optimal dose of

5.63 g kg-1 feed. The cultivation of the biofloc system was more effective with ginger diet for 60 days compared to the ginger and garlic diet for 90 days on fish growth. Cultivating the biofloc system for 60 days with the ginger diet is recommended for fish farming.

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