The effect of garlic (*Allium sativum*) and turmeric (*Curcuma longa*) extract addition in commercial feed on feeding rate, feed efficiency and feed conversion ratio of gouramy fish (*Osphronemus gouramy*)

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Abstract. Gouramy is known to its low appetite and slow growth. Attractants are ingredients that are mixed in small amounts of feed to increase food intake, growth, and fish consumption for feed. Garlic contains at least 33 sulfur components that give a distinctive odor and various medicinal effects. Turmeric contains essential oils composed of monoterpenes and is an effective odor stimulating precursor compound used as an attractant. This study aims to determine the effect of giving turmeric and garlic extracts at different doses on feed consumption, feed efficiency and feed conversion ratio in gouramy. This study used an experimental method with 5 treatments; P₀= control, P₁=1% garlic extract addition, P₂= 1.5% garlic extract addition, P₃= 1% turmeric extract addition and P₄= 1.5% turmeric extract additions with 4 replications using 10 fish in each. The results showed that the highest feed consumption value was in the treatment of P₁ and P₂, the lowest conversion ratio and the highest value of feed efficiency was found in the treatment of P₂ and P₃. So it can be concluded that the addition of 1.5% garlic extract or 1% turmeric extract is effective as an attractant and effective for increasing the growth of gouramy.

1. Introduction
Gouramy is one of the leading freshwater commodities which is known to have increased production by 110% from 2015-2018 with total production reaching 356.53 thousand tons [1]. However, gouramy cultivation has specific problems, it’s known to has low appetite and slow growth.

Attractants are ingredients that are mixed in small amounts of feed to increase food intake, growth, and fish consumption for feed [2, 3]. The use of attractants in the fish feed industry has become important because attractants provide signals that allow fish to recognize these pellets as their food source [4]. Chemicals made from organic ingredients, betaine, terpenes, and sulfur compounds can be attractants that induce taste and smell stimulation for fish [5].

Garlic (*Allium sativum*) is a type of tuber that is widely grown in various countries in the world and contains at least 33 sulfur components, several enzymes, 17 amino acids and many minerals. Garlic
has a higher sulfur component compared to other Allium species. This sulfur component provides the distinctive odor and various medicinal effects of garlic [6].

Turmeric is a type of spice that is widely used as a spice in various types of cooking and contains essential oils and curcuminoids. Turmeric rhizome essential oil is composed of monoterpenes and sesquiterpenes. β-element, α-terpineol and p-cymene [7] from the monoterpene group are odor stimulant precursor compounds that are effective as attractants [8] as well as curcuma, α and β turmerone, zingiberen and curcumin from the sesquiterpen group [9]. The discovery of sulfur content in garlic and terpene compounds in essential oils is expected to be an attractant in feed to increase fish appetite.

The amount of feed consumption is the amount of feed consumed by fish during the rearing period. Fish will use this feed as a source of energy for metabolism so it can grow and develop. The comparison between the feed eaten and the fish growth will show the value of feed utilization efficiency and feed conversion ratio. This is important to note because it shows the quality of the feed. The value of feed efficiency is inversely related to the feed conversion ratio (FCR). The higher the feed utilization efficiency value, the better the feed utilization by the fish. A high feed efficiency value will be inversely proportional to the value of the feed conversion ratio (FCR).

The study of spices as attractant on gouramy fish is not widely known. This study observed the effect of giving garlic (A. sativum) and turmeric (Curcuma longa) as attractants with different doses on feed consumption, feed utilization efficiency, and feed conversion ratio in gouramy (Osphronemus gouramy).

2. Material and methods
2.1. Materials
The tools used in the study were 20 aquariums with a size of 30x30x30 cm for 5 treatments and 4 replications, aerator, aeration hose, aeration stone, reservoir tub, fiber tub, spray bottle, tray, jar, digital scale, filter, plastic bag, spoon, millimeter block paper, thermometer, pH meter, DO (dissolved oxygen) meter, ammonia test-kit, knife, rotary evaporator, waterbath. The materials used for the manufacture of the test feed were garlic (A. sativum), turmeric rhizome (C. longa), aquadest, 70% ethanol, 95% ethanol, ice cubes, CP Prima's commercial feed (Hi-Pro-Vite ff999) 1.3-1.7 mm. The method used in this research was the experimental method using a completely randomized design (CRD) which consists of 5 treatments with 4 repetitions each as follows:

P0 = 100% commercial feed (control)
P1 = 100% commercial feed + 1% garlic extract (10 g/kg)
P2 = 100% commercial feed + 1.5% garlic extract (15 g/kg)
P3 = 100% commercial feed + 1% turmeric extract (10 g/kg)
P4 = 100% commercial feed + 1.5% turmeric extract (15 g/kg)

2.2. Extract making
The garlic and turmeric extracts were obtained through a maceration process. Garlic and turmeric were washed from the dirt and then peeled and thinly sliced. The garlic and turmeric slices were then being dried using oven. The dried slices then crushed into powder form. Garlic powder was macerated with 70% ethanol solvent and turmeric was macerated with ethanol 95% solvent with a 1:3 ratio of ingredients and solvents in the first stage. Maceration was done in two repetitions with a ratio of 1:2 in the second stage. The results of the first and second filtrate were continued to the evaporation process using an evaporator with a temperature of 60-70°C. The results from the evaporation were then heated for 24-36 hours to obtain a thick extract of garlic and turmeric.

2.3. Feed preparation
Commercial feed (ff-999) was sprayed with 1% and 1.5% turmeric extract or 1% and 1.5% garlic extract solvent using a sprayer. The feed that has been given garlic and turmeric extract then dried under the sun. The dried feed is ready to be used as treatment feed for gouramy fish.
2.4. Aquarium preparation
The preparation of the tools used in the study began with the sterilization process using a 10 ppm chlorine solution. The aquarium and other equipment are first washed with soap and rinsed, then given a chlorine solution and rinsed again until clean, then dried. The dry aquarium is then filled with 20 liters of fresh water and aerated for 24 hours before being filled with the fish.

2.5. Pisciculture
The test fish used in this study was healthy gouramy (O. gouramy) 7 ± 0.5 cm in size. Before being put into the test aquarium, the fish were acclimatized for two hours. Each aquarium is filled with 10 gouramy fish. Fish are reared for 28 days by feeding as much as they could 3 times a day.

2.6. Data Collection
The main parameters observed in this study were the level of feed consumption, feed conversion ratio and utilization efficiency of gouramy feed. Analysis of the level of feed consumption, feed conversion ratio and feed utilization efficiency of the test fish was carried out at the beginning and end of the experiment to determine the differences between each treatment given. The test fish were fed as much as they could 3 times a day. The calculation of the amount of feed consumed is carried out every day while the measurement of body weight gain of fish is carried out every 7 days.

a. Consumption rate
The level of feed consumption (TKP) according to Pereira et al. [10] calculated by the formula:

\[ TKP = F_1 - F_2 \]  

Description :
TKP : Level of feed consumption (grams)
F1 : Total weight of initial feed (grams)
F2 : Weight of leftover feed (grams)

b. Feed conversion ratio
Feed Conversion ratio or FCR according to Effendi [11] calculated by the formula:

\[ FCR = \frac{F}{(W_t + D) - W_o} \]

Description:
FCR : Food Conversion Ratio;
F : Amount of fish feed given during the study (g);
Wt : Biomass of fish at the end of the study (g);
D : weight of dead fish (g);
Wo : Biomass of fish at the beginning of the study (g).

c. Feed efficiency
Feed Efficiency according to Tacon [12] calculated by the formula:

\[ EPP = \frac{W_t - W_0}{F} \times 100\% \]

Description:
EPP : Feed Efficiency (%);
W0 : Biomass of fish at the beginning of the study (g);
Wt : Biomass of fish at the end of the study (g);
F : Amount of fish feed given during the study (g).
2.7. Data analysis

Data on feed consumption, feed utilization efficiency and feed conversion ratio were analyzed using Analysis of Variance (ANOVA). If the treatment results show a significant effect, then proceed with the Duncan Multiple Range Test (DMRT) to determine the best treatment.

3. Result and discussion

3.1. Consumption rate

The results of statistical analysis of giving garlic and turmeric with different concentrations in the feed showed very significant results (p < 0.01) on the total feed consumption of gouramy.

Table 1. The average feed consumption of gouramy with the addition of several different doses of attractants (grams)

| Treatments | Food Consumption ± ds |
|------------|-----------------------|
| P0         | 1.8255 ± 0.1358       |
| P1         | 2.3055 ± 0.3602       |
| P2         | 2.3652 ± 0.1929       |
| P3         | 0.9177 ± 0.0978       |
| P4         | 0.9480 ± 0.0252       |

a, b, c, d: different notations in the same column indicate very significant differences (p < 0.01).

The high value of gouramy feed consumption treated with 10 and 15 g/kg of garlic is caused by the presence of sulfur compounds which are responsible for taste, aroma, and pharmacological properties [13]. Harada [14] stated that garlic has a pungent smell which is very attractive to Ocyurus chrysurus and Misgurnus anguillicaudatus and does not have a bitter taste so it is very popular with fish. According to Lee and Gao [15], garlic has also been widely used and proven effective as an attractant in most aquatic animals such as Pelodiscus sinensis, Ctenopharyngodon idellus, Cyprinus carpio, Carassius auratus, and Oreochromis niloticus because allisin compounds from onions can induce fish to eat. feed, thereby increasing the value of feed consumption [16].

The value of the test fish feed consumption which was given 10 and 15 g/kg of turmeric was lower than the predicted control because of the bitter taste of turmeric. Chempakam and Parthasarathy [17] stated that among all the spices from the tuber class, turmeric is a spice that has a strong and distinctive bitter taste. Turmeric essential oil contains 40-65% cumin dehide which comes from the monoterpenes group and is the largest component of the essential oil which is responsible for the aroma and bitter taste of turmeric. According to Nascimento et al. [18], low feed consumption is given to turmeric because turmeric increases the release of corticotrophin-releasing hormone (CRH), which is a very good neupeptide for releasing anorexigenic effects in fish.

3.2. Feed conversion ratio

The results of statistical analysis of giving garlic and turmeric with different concentrations in the feed showed very significant results (p < 0.01) on the feed conversion ratio of gouramy.

Table 2. The average feed conversion ratio (FCR) of gouramy with the addition of several different doses of attractants

| Treatments | FCR ± ds |
|------------|----------|
| P0         | 1.5027 ± 0.1200 |
| P1         | 0.9395 ± 0.0138 |
| P2         | 0.8617 ± 0.0451 |
| P3         | 0.8235 ± 0.0635 |
| P4         | 1.0475 ± 0.0402 |

a, ab, b, c, d: different notations in the same column indicate very significant differences (p < 0.01).
The low FCR value in gouramy which is fed with an additional 1.5% garlic extract is a result of the presence of the allisin compound in onions. Allisin compounds will trigger an increase in the concentration of amino methionine acid in the body, so that the body can produce anti-toxin enzymes, stimulate the immune system, prevent platelet clumping, increase hormone metabolism, become antibacterial, and antioxidant [19]. Research by Samson [20] on tilapia (O. niloticus) showed that the addition of 1.5% garlic to feed significantly reduced the FCR value when compared to control feed. This is also proven by research which found that the addition of garlic to tilapia feed with a higher concentration of 3% [21] to 5% [22] can still significantly reduce the FCR value compared to controls.

Giving turmeric extract with a concentration of 1% (10 g/kg) is good for reducing FCR because there are terpenoid compounds in turmeric that stimulate the digestive system in fish by increasing the activity of the enzymes lipase, trypsin, chemotrypsin, and amylase [23], increasing mass weight, body and reduce the value of the feed conversion ratio due to the increase in the quality of absorption and digestion of feed by fish [24]. The FCR value of the test fish which was given an additional 15 g/kg was higher than the addition of 10 g/kg indicating that in giving turmeric with this concentration, the terpenoid compounds were not used optimally by the fish body, so it was not good for reducing the FCR of the tested fish.

3.3. Feed efficiency
The results of statistical analysis of giving garlic and turmeric with different concentrations in the feed showed very significant results (p <0.01) on the efficiency of feed utilization.

| Treatments | Feed Efficiency ± ds |
|------------|----------------------|
| P0         | 66.853a ± 5.113      |
| P1         | 106.385c ± 1.597     |
| P2         | 116.208d ± 6.360     |
| P3         | 121.972d ± 10.185    |
| P4         | 95.531b ± 3.644      |

a, b, c, d: different notations in the same column indicate very significant differences (p <0.01).

The highest efficiency value was obtained from the P3 treatment (1% turmeric extract addition) with the value of 121.97%, which means that feed can be maximally utilized for the body's metabolic processes. This is in line with research by Sahu et al. [25] which stated that the addition of 1% turmeric flour significantly increased the growth of rohu fish. The high value of feed utilization in test fish with the addition of 1% turmeric extract is an indication of the increased digestibility of feed nutrients and the antioxidant activity of turmeric [26] which stimulates protein synthesis by the enzymatic system. According to Bhavani and Sreenivasa [23], the active compounds in turmeric can protect red blood cells, affect the liver and stimulate the secretion of bile, lipase, maltase, amylase, trypsin, and stimulate the activity of the pancreas to digest food.

The value of feed utilization efficiency in test fish given 1% and 1.5% garlic extract was significantly different from the control treatment, with the highest efficiency value found in the garlic treatment of 15 g/kg. This is in line with the research by Mesalhy et al. [27], tilapia fed with the addition of garlic as much as 10 or 20 g/kg showed a significant increase in body biomass. The addition of garlic is known to be very good for increasing the final biomass, final body length, weight gain, and specific growth values in fish [28].

4. Conclusion
Giving garlic extract 1.5% or 1% turmeric extract to gouramy is known to be effective as an attractant, and can increase the growth of test fish with the highest feed consumption value in the treatment of 1-
1.5% garlic extract, the lowest conversion ratio value (FCR) and highest utilization efficiency was found in the treatment of 1.5% garlic extract or 1% turmeric extract.

5. References
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