Effect of substitute fig flour, *Ficus racemosa*, in artificial feed for growth of *Osphronemus goramy*

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Abstract. Soybean flour is a vegetable protein ingredient often used in the fish feed formulation process, which has a high price and is still imported. One of the ingredients that can be used to substitute vegetable protein sources from soybean flour is fig flour (*Ficus racemosa*). The study aimed to analyze the effect of substituting fig flour in artificial feed used for the growth of giant gourami, *Osphronemus goramy*. The study used an experimental method with five treatments and five replications, namely (A) 0% figs flour and 40% soybean flour (control); (B) 10% figs flour and 30% soy flour; (C) 20% figs flour and 20% soybean flour; (D) 30% figs flour and 10% soybean flour; (E) 40% figs flour and 0% soybean flour. The observed parameters were absolute weight gain (Wm), absolute length gain (Lm), daily weight gain, feed efficiency (EP), feed conversion ratio (FCR), and water quality. Data were compared by analysis of variance with a 0.05 significance level ($P<0.05$) and Duncan's test. Based on Duncan's test for absolute weight and daily weight parameters, treatment C significantly differed from other treatments. The best feed conversion ratio was feed C, followed by feed D, feed B, feed E, and feed A. The water quality values during the research were life-supporting for the studied *O. goramy* specimens. The substitution with 20% fig flour in the artificial feed significantly affected the growth of *O. goramy*.
Key Words: artificial feed, gourami, fig flour, substitution, growth.

Introduction. Giant gourami, *Osphronemus goramy*, is a freshwater fishery commodity with savory, delicious meat and economic value. For now, gourami is in great demand in the food industry (Amornsakun et al 2014a; Kristanto et al 2019; Dastin et al 2021). A large gap appeared in the gourami's ratio between production and demand. In addition, *O. goramy* culture has a good potential to be developed, but its slow growth is an obstacle faced by cultivators (Amornsakun et al 2014b; Arifin et al 2019). The external factors that can affect the growth are environment and feed. Feed is needed by *O. goramy* in providing energy and material for growth. Feed energy is used for metabolic activities such as respiration, ion transport, body temperature regulation, and other activities (Patwary et al 2013; Efrizal et al 2020; Lubis et al 2021).

The feed cost is the highest production cost in aquaculture activities from the total production cost. The artificial feed can increase the production, allowing a short maintenance time, is economical and able to provide benefits (Susatyo et al 2016; Villarino 2020). A research effort is required to determine the raw materials used in making artificial feed. The selection of ingredients for fish feed needs to consider several conditions: good quality, affordable prices, and continuity (Efrizal et al 2018; Lubis et al 2021). One of the ingredients that are often used in the fish feed formulation process is the soybean flour. Soybean is one of the ingredients of vegetable protein which is expensive and still imported, causing feed prices to remain high. Reducing the use of soybean flour in feed formulations requires local raw materials as an alternative that is easily obtained, abundantly available, does not compete with human needs and has high nutritional value (Abdalbakee & Mohammed 2019; Hundare et al 2018; Das et al 2018). One of the ingredients that can be used to replace the vegetable protein sources from soybean flour is the fig flour (*Ficus racemosa*) (Zakaria et al 2022).

Figs are very commonly found in Indonesia and are still not optimally utilized by the fish farmers as feed ingredients. The fruit of this plant is thought to have a high nutritional content so that it can be used as feed, but there is little scientific information and publications on this topic (Bhalerao et al 2014; Bhogaonkar et al 2014). The protein content of figs is 10.63%, vitamin C, calcium, phosphorus, and several essential amino acids that can cover the deficiency of the amino acids found in other feed ingredients. It is hoped that the substitution with fig flour can reduce the use of expensive soybean and can cover the shortcomings that exist in the soybean (Aryani et al 2009; Bhalerao et al 2014; Bhogaonkar et al 2014; Sivakumar et al 2019). In response to the community's demand for *O. goramy*, many innovations were created to increase its production. This research is important to determine the potential use of fig flour as one of the ingredients for *O. goramy* feed. This research was conducted by substituting soy flour with fig flour in artificial feeds with different compositions, as an effort to reduce the use of soy flour, while obtaining at least the same performance values for the growth parameters of *O. goramy*.

Material and Method

Time and sites. This research was conducted from July to November 2020 at the Bungus Fish Seed Center (BBI), East Bungus Village, Bungus Teluk Kabung District, Padang. Data analysis was carried out at the Animal Ecology Laboratory, Andalas University, Indonesia.

Experimental design and formulated feed. The method in this study used an experiment with a completely randomized design with 5 treatments and 5 replications. The treatments given in this research are:
(A) an artificial feed with substitution with 0% figs flour and 40% soybean flour (control);
(B) an artificial feed with substitution with 10% figs flour and 30% soybean flour;
(C) an artificial feed with substitution with 20% figs flour and 20% soybean flour;
(D) an artificial feed with substitution with 30% figs flour and 10% soybean flour;
(E) an artificial feed with substitution with 40% figs flour and 0% soybean flour.
The feed formulation was obtained with the try and error method, by mixing fish flour, soybean flour, cornflour, tapioca flour, fine bran, fish oil, vitamin, and mineral mix. Feed was given 3 times a day, in a dose of 5% of fish biomass. The maintenance of gourami was carried out for 60 days and the length and weight of the fish were measured every 15 days.

Data collection and sample analysis. To determine the growth performance of *O. goramy* seeds, the following parameters were calculated. The absolute weight (Wm), absolute length (Lm), and daily weight were determinedaccording to Fujaya et al (2021), while feed efficiency (EP), and feed conversion ratio (FCR) referred to Gebremichael et al (2021). During the maintenance, water quality measurements of pH, DO, and ammonia were carried out to control the maintenance media.

Statistical analysis. To determine the effect of substitute with fig flour in artificial feed, the data were analyzed by parametric statistics using the analysis of variance with a 0.05 significance level. The significantly affected parameters were further tested using the Duncan's test ($P<0.05$). Water quality data were analyzed descriptively based on the measurement results.

Results. *O. goramy* data obtained for 60 days are absolute weight, absolute length, daily growth, feed conversion ratio, and feed efficiency parameters. Based on the analysis of variance, the substitution with fig flour in artificial feeds had a significant effect on the absolute weight, daily weight, absolute length, feed conversion ratio, and feed efficiency of *O. goramy* ($P<0.05$). The average values obtained from each parameter are presented in Table 1. The highest absolute weight of gourami fish was found with the feed C (5.79±0.40 g), followed by feed B (3.88±0.27 g), feed D (3.66±0.25 g), feed A (3, 23±0.15 g), and feed E (2.58±0.20 g). The average daily weight growth of *O. goramy* ranged from 0.04±0.003 g day^{-1} to 0.10±0.007 g day^{-1}. The highest daily weight growth of *O. goramy* was found with the feed C (0.10±0.007 g day^{-1}), followed by feed B

(0.07±0.004 g day^{-1}), feed D (0.06±0.004 g day^{-1}), feed A (0.05±0.004 g day^{-1}) and feed E (2.58±0.20 g day^{-1}). Based on Duncan's test for absolute weight and daily weight parameters, feed A was not significantly different from feed B, feed D, and feed E, while the treatment C was significantly different from other treatments.

Table 1

The average value of the absolute weight, daily weight, absolute length, feed conversion ratio, and feed efficiency of gourami fish

Parameters	*Treatment±SE*				
	A	*B*	*C*	*D*	*E*
Absolute weight (g)	3.23±0.15^{ab}	3.88±0.27^{b}	5.79±0.40^{c}	3.66±0.25^{b}	2.58±0.20^{a}
Daily weight (g day^{-1})	0.05±0.004^{ab}	0.07±0.004^{b}	0.10±0.007^{c}	0.06±0.004^{b}	0.04±0.003^{a}
Absolute length (mm)	8.96±0.70^{a}	12.21±1.22^{abc}	16.91±1.57^{c}	13.73±1.63^{bc}	9.70±1.35^{ab}
Feed conversion ratio (g)	5.57±0.45^{c}	4.61±0.39^{abc}	3.71±0.39^{a}	4.32±0.40^{ab}	4.92±0.22^{bc}
Feed efficiency (%)	18.46±1.61^{a}	22.33±1.89^{ab}	28.04±2.70^{b}	23.86±1.96^{ab}	20.48±0.95^{a}

Artificial substitution feeds contained: (A) a mix of 0% figs flour and 40% soybean flour (control); (B) a mix of 10% figs flour and 30% soy flour; (C) a mix of 20% figs flour and 20% soybean flour; (D) a mix of 30% figs flour and 10% soybean flour; (E) a mix of 40% figs flour and 0% soybean flour; SE-standard error.

Based on Table 1, the longest absolute length was observed in the feed C (16.91±1.57 mm) then in the feed D (13.73±1.63 mm), feed B (12.21±1.22 mm), feed E (9.70±1.35 mm), and feed A (8.96±0.70 mm). The best feed conversion ratio was observed in the feed C (3.71±0.39 g), followed by feed D (4.32±0.40 g), feed B (4.61±0.39 g), feed E (4.92±0.22 g), and feed A (5.57±0.45 g). Table 1 also showed that feed B is not significantly different from other feeds. The highest feed efficiency was observed in the feed C (28.04±2.70 %), followed by feed D (23.86±1.96 %), feed B (22.33±1.89 %), feed E (20.48±0.95 %), and feed A (18.46±1.61 %). On the feed efficiency parameter, feed B and D were not significantly different from other feeds.

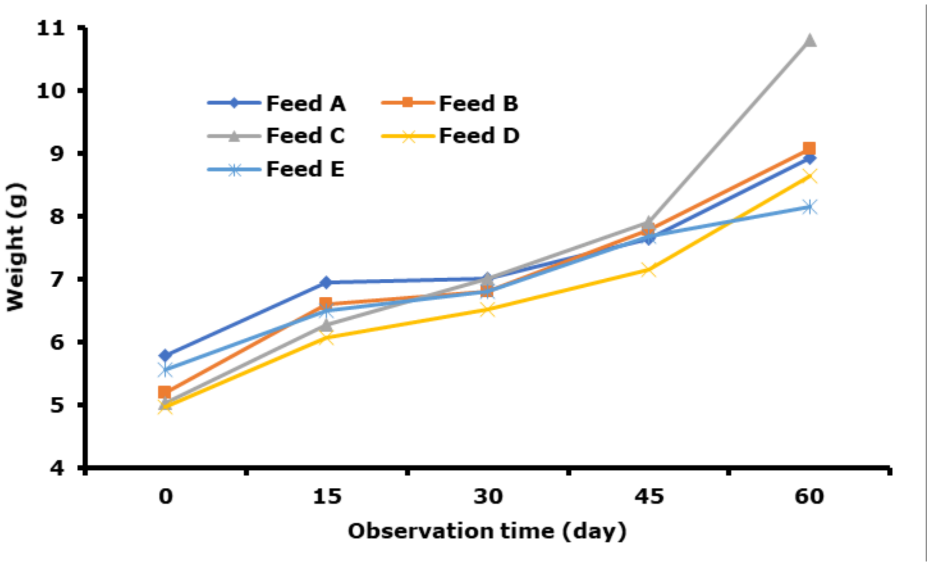

Figure 1. Daily weight (g day^{-1}) of *Osphronemus goramy*.

Figure 1 showed almost the same daily growth from day 0 to day 45. However, on days 45 to 60, treatment C showed a significant difference in growth compared to other treatments. This indicates that the test fish began to respond to differences between feeds on day 45. Water quality is one of the determining factors for the success of fish farming. For this reason, it is necessary to control the water quality during the maintenance period. The value of water quality during the study is seen in Table 2: the temperature range during the study was 26-29^{o}C, the pH ranged from 7.1-7.5, the DO ranged from 5.17-7.79 mg L^{-1}, and the ammonia ranged from 0.008-0.052 mg L^{-1}.

Table 2

Water quality of *Osphronemus goramy* during the maintenance period

Parameters	*Range*
Temperature (^{o}C)	26-29
pH	7.1-7.5
DO (mg L^{-1})	5.17-7.79
Ammonia (mg L^{-1})	0.008-0.052

Discussion. Feed C with 20% substitution with fig flour in the artificial feed was the most effective feed for the growth of *O. goramy*. According to Ogunkalu (2020), fish will consume feed optimally according to their energy needs; most of the feed will be used for metabolic processes and for other activities such as growth. The growth of an organism is determined by the quantity and type of feed it consumes must be in line with its eating habits; if feed is not appropriate, then its growth will be stunted or relatively low (Efrizal et al 2020; Lubis et al 2021; Zakaria & Saragih 2021).

The increased growth of *O. goramy* during 60 days of maintenance showed that the feed provided has sufficient nutrients and energy to carry out metabolic processes in the body, so the rest can be utilized by the body for growth (Fauzi et al 2016; Munir et al 2016; Zakaria et al 2019). The feed given to the experimental fish has a different effect on its growth. The existence of a significantly different effect among feed C and all treatments was thought to be due to differences in the nutritional content of each treatment. According to Rahmawan et al (2020), the growth of *O. goramy* is influenced by the amount of feed consumed by during maintenance. A good response of fish will affect its preference for the test feed and it will encourage fish growth (Hariyadi et al 2018; Ogunkalu 2020; Efrizal et al 2020; Lubis et al 2021). Growth is influenced by the fish size, protein quality and quantity, differences in material composition, amount of feed, and frequency of feeding. Growth is also influenced by the good quality of protein contained in the feed (Budi et al 2015).

Hariyadi et al (2018) stated that the lower the feed conversion value, the more efficient the feed used by fish for growth both in weight and length. The feed conversion ratio is influenced by the absorption of feed nutrients by the digestive tract (Herawati et al 2020). The low value of the feed conversion ratio in feed C was thought to occur because the feed provided had met the optimal nutritional requirements for the growth of gourami fish. A feed with 20% substitution with fig flour can be used properly for the growth of *O. goramy* (Luo et al 2004). Efficiency and feed conversion ratio are closely related and affect the fish growth rate. The smaller the feed conversion value, the more efficient the use of feed in the fish's body. A better quality of the feed results in an optimal feed and consequently in a more effective growth of fish. The smaller the conversion value, the better the feed efficiency and the greater the weight of fish at the same level of feed consumption (Zahrani et al 2013; Hariyadi et al 2018; Kong et al 2020).

It is suspected that fig flour can supplement amino acids in the feed according to the needs of *O. goramy*. A low value of feed efficiency is thought to be due to the low feed digestibility (Nunes et al 2014; Warith et al 2019), causing a suboptimal feed absorption and its inefficient use by the gourami. A substitution with figs flour higher than 20% is thought to increase the crude fiber content in the feed, thereby reducing the efficiency of feed utilization by the fish. According to Pouil et al (2019), the differences in crude fiber also affect the nutrient digestibility, because crude fiber can inhibit the work of digestive enzymes.

During the maintenance, the water quality parameters measured included temperature, pH, DO, and ammonia. Fish are cold-blooded (poikilothermal) animals whose body temperature is the same as the water in their environment (Prakoso et al 2021). The water temperature during the maintenance of *O. goramy* in the pond ranges from 25 to 29^{o}C. The optimal temperature for the cultivation of gourami, according to Prakoso et al (2019), ranged from 28-30^{o}C. These results indicate that the temperature range during the study is still in the optimal limits. The pH of the water during the study ranged from 7.1-7.5. pH can affect the growth of fish. Gourami fish has a wide tolerance to acidity, in the range 5-9 (Arifin et al 2019; Setijaningsih 2019).

The range of dissolved oxygen during the study is 5.17 to 7.79 mg L^{-1}. The dissolved oxygen content is one of the most important factors in aquatic systems and is necessary for fish respiration (Herawati et al 2020; Pinandoyo et al 2021). When the temperature increases, the metabolic rate of fish increases, causing the respiration rate of fish to also increase, and the oxygen concentration in the waters will decrease drastically, which can cause fish death (Prakoso et al 2019,2021).

Ammonia is the result of the process of breaking down protein from feed residues, metabolic products, and suspended materials. It settles to the bottom of the waters causing fish poisoning, due to its toxicity. The remnants of food and feces that settle to the bottom of the waters will then decompose, increasing the levels of ammonia (Handajani et al 2018; Melki et al 2018). The ammonia values measured at the beginning and end of the study ranged between 0.052 and 3.6 ppm. The level of ammonia in water is generally the result of feed residues and fish metabolism, in the form of fish waste (Ghufron et al 2020).

Conclusions. Based on the research that has been carried out, it can be concluded that the substitution of fig flour in the feed has a significant effect on the growth of *O. goramy*. A substitution of 20% fig flour in artificial feed resulted in the best growth for *O. goramy*.

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Conflict of interest. The authors declare no conflict of interest.

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