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The Effectiveness of Dietary Fucoidan Compared to the Combination of Fucoidan with Turmeric on the Growth of African Catfish (*Clarias Gariepinus*)

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ABSTRACT

To meet the needs of fish consumption for the community, African catfish are cultivated intensively. African catfish cultivation is carried out intensively with high stocking density, but some disadvantages inhibit growth. To support growth, it is done by giving a combination of fucoidan supplements with turmeric. Fucoidan and turmeric are known to increase fish growth, but there are no reports of using a combination of fucoidan and turmeric given in feed to increase fish growth. Therefore, this study wants to determine the effect of fucoidan supplementation with turmeric on the growth of African catfish. The method used was a completely randomized design with treatment B: (400 mg fucoidan + 1350 mg turmeric extract) kg^{-1} feed, C: (800 mg fucoidan + 1200 mg turmeric extract) kg^{-1} feed, D: (1200 mg fucoidan + 1050 mg of turmeric extract) kg^{-1} of feed and control (A), each with 4 replications. The parameters observed were weight and length gain, survival growth rate (SGR), feed conversion rate (FCR), and feed efficiency (FE). Data were analysed using analysis of variance (ANOVA) at the 95% confidence level and continued with Duncan's Multiple Range Test (DMRT). The results showed that the combination of fucoidan supplementation with turmeric significantly increased ($p < 0.05$) weight and length growth, SGR, FCR, and FE. The addition of fucoidan supplements with turmeric can be used to cultivate African catfish with an optimal dose (1200 mg fucoidan + 1050 mg turmeric extract) kg^{-1} feed.

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1. INTRODUCTION

Brown seaweed is a source of polysaccharides and glycoproteins. It functions as an immunostimulant, antiviral and anti-tumor. One of the important polysaccharides in brown seaweed is fucoidan and its derivatives, such as alginate (Sinurat & Peranginangin, 2015). Fucoidan is the result of the extraction of brown seaweed, is an herb that comes from marine organisms. So far, there have been several studies using fucoidan for fish. Giving

fucoidan through the feed can increase the immunity of catfish (Purbomarto et al., 2019) and its growth (Purbomartono, 2019). The same study showed that fucoidan could increase immunity as reported by Isnansetyo et al. (2016), injection using fucoidan derived from brown seaweed *S. cristaefolium* in tilapia at a dose of 0.4–0.6 mg kg^{-1} was proven to be effective in increasing non-specific immunity, explaining that fucoidan has the potential to be used as an immunostimulant to prevent and control fish disease.

This shows that fucoidan as an immunomodulator is thought to be able to support better growth than control in catfish (Purbomartono, 2019). Apart from fucoidan, which comes from the extraction of brown seaweed, turmeric is also known to increase fish growth from terrestrial plants. The powdered young turmeric inclusion positively influenced the growth performance and survival of the fish (Sanchez et al., 2019). Dietary turmeric powder positively affects innate immunity and disease resistance in common carp. Turmeric powder might be used as an antimicrobial agent and immunostimulant without deleterious effect on fish and their environment. Moreover, its inclusion in common carp diets at a level of 2.0 g kg^{-1} diet could improve growth and feed utilization and enhance fish health (Abdel-Tawwab & Abbass, 2017). This study aims to determine the effectiveness of diet fucoidan given alone with fucoidan combined with turmeric on the growth of African catfish.

2. METHODS

The main object of this research was fucoidan and turmeric. Fucoidan is the result of the extraction of brown seaweed (*Sargassum* sp.), which was obtained from the Menganti beach, Kebumen Regency, Central Java, Indonesia. Turmeric was bought from a traditional market in Purwokerto, Central Java. The catfish used was 6-8 cm in size purchased from fish farmers in Dukuhwaluh village, Purwokerto, Central Java.

The materials needed for extraction were HCl 0.1 N & 0.2 N, Whatman 40 paper, rotary evaporator, 95% ethanol, magnetic stirrer, $CaCl_2$ 2M, centrifuge (8000 g, 4 ^oC), NaOH, coarse filter, *haematocrit tube*. Meanwhile, the ingredients used to mix the herbal extract with pellet feed were 0.1% progol, spray, and dryer.

3. EXTRACTION OF FUCOIDAN

The extraction of brown seaweed was carried out by methods (Kim et al., 2007). The seaweed obtained was washed with fresh water until clean to remove the attached salts and epiphytes, then it was dried in the sun by drying it indirectly. The wind-dried seaweed is cut (± 0.5 cm) and blended. Then depigmentation was carried out by soaking 100 g of seaweed flour in ethanol (95%) for 24 hours. Then the ethanol was discarded, replaced with 1 L 0.1 N HCI (Merck), and soaked for 24 hours at room temperature. After 24 hours, the HCl solution was filtered with a coarse cloth sieve, and the remaining seaweed was re-extracted with the addition of 1 L 0.2 N HCI for 2 hours at 70 ° C after being filtered (retentate). Furthermore, the 0.2 N HCl solution was re-filtered with a coarse filter as in the first filtration process. Further, the first and second filtrate obtained was put together. The whole filtrate (which has been put together) is re-filtered with Whatman 40 paper, then evaporated with a rotary evaporator at a temperature of 60^oC to a volume of 100 mL. Furthermore, purification is carried out with ethanol precipitation. The fucoidan extract was obtained after evaporation, then added 3 x volume of 95% cold ethanol while stirring with a magnetic stirrer and allowed to stand for 2 hours at room temperature.

Subsequently, centrifugation (8.000 g, 4 ° C) was conducted for 15 minutes. The precipitate obtained was dissolved in distilled water, which pH was adjusted to 2 with the addition of HCI. Then $CaCl_2$ (Merck) was added to a final concentration of 2 M, and then it was centrifuged again as in the first centrifugation (8.000 g, 4^oC for 15 minutes). Furthermore, the sediment (containing alginate) was removed while the filtrate (supernatant containing fucoidan) was collected. To obtain fucoidan, the supernatant was reprecipitated by adding 3 times by volume of 95% ethanol as in the first precipitation process.

4. TURMERIC EXTRACTION

The turmeric and ginger were cleaned first, cut into thin strips, and then dried in the sun. After the turmeric and ginger were dry, they were smoothened using a blender. Furthermore, turmeric and ginger powder were sieved to obtain a fine powder. Powder maceration was carried out with distilled water for 24 hours (100 mL kg^{-1} feed). Then the solution was put into the sprayer and then sprayed onto the feed. Especially for fucoidan, given progol 1% as an adhesive. The feed was dried at room temperature. After it dried, then put in a plastic bag and stored in the refrigerator until used.

5. RESEARCH DESIGN

The study used a completely randomized design, with 3 treatments and 1 control, each with 4 replications. This study consisted of 2 parts, the first treatment using fucoidan with different doses. The second is the combination of fucoidan with turmeric. The first research treatment was:

Control
4 g feed + fucoidan (g kg^{-1} feed)
6 g feed + fucoidan (g kg^{-1} feed)
The second research was:
A: control
B: feed + (400 mg fucoidan + 1350 mg turmeric) kg^{-1}feed
C: feed + (800 mg fucoidan + 1200 mg turmeric) kg^{-1}feed
D: (1200 mg fucoidan + 1050 mg turmeric) kg^{-1}feed

Feed was given at a dose of 3% of the weight of fish biomass in the morning at ± 07.00 WIB and in the afternoon at ± 17.00 WIB. The parameters measured in this study were growth which included:

Weight gain (WG) = Wt-W0

Length gain (LG) = Lt-L0

Feed Conversion Rate (FCR) $= \frac{F}{Wt+D)-W0}$

Feed Efficiency (FE) $= \frac{Wt-Wo}{F}$ x 100 %

Specific growth rate (SGR) $= \frac{Wt-W0}{t} X\ 100\%$

Data analysis

Data on weight and length gain (WG and LG), SGR), FCR, and FE were analyzed using one-way ANOVA, with a confidence level of ($p< 0.05$). If there is a significant difference then the Duncan Multiple Range Test is used to determine the significance of the difference between the treatments.

6. RESULTS AND DISCUSSIONS

Growth

Growth is an increase in weight, length, and volume. In aquaculture, weight growth is the main indicator of achieving productivity. Addition of diet fucoidan and diet combination fucoidan and turmeric through the feed to African catfish in this study is expected to increase optimal growth during 60 days of experiments. Based on the results of the study, the combination of the fucoidan diet with turmeric is more effective than the fucoidan diet alone. All growth parameters such as weight gain (WG), length gain (Lt) and specific growth rate (SGR) are more optimal on a combined diet (Table 1).

Table 1. Measurements of the weight and length gain and SGR of catfish

	Treatment				***Treatment***		
	Fucoidan				**Fucoidan + Tumeric**		
g kg^{-1} feed	**WG**	**Lt**	**SGR**	***g kg^{-1} feed***	**WG**	**Lt**	**SGR**
Control	4.46[a]	3.48[a]	2.87[a]	**Control**	8.25[a]	3.70[a]	2.97[a]
4	5.75[b]	4.22[b]	3.33[b]	**0.4+1.35**	13.18[b]	5.51[b]	3.79[b]
6	6.36[b]	4.12[b]	3.51[b]	**0.8+1.2**	13.10[b]	5.95[b]	3.76[b]

Note: Data are shown in mean. The results followed by the different letter were significantly different ($p<0.05$).

Weight and length gain, specific growth rate (WG, LG and SGR)

Feeding combination fucoidan with turmeric can significantly increase the weight gain, length gain and specific growth rate of catfish ($p<0.05$) at optimal dose (0.4 +1.35) g kg^{-1} feed (B). The combination of fucoidan and turmeric extract given through feed has been shown to increase the growth of African catfish. The results of previous research showed that fucoidan supplementation with a dose of 4000 mg kg^{-1} of feed was able to increase the weight growth of African catfish by 5.57 g during the 40 days experiment (Purbomartono, 2019). Traifalgar

et al. (2009) reported that fucoidan from seaweed extract *U. pinnatifida* can be used as a growth promoter in shrimp. Fucoidan cross-reacts with the myosin protein causing increased muscle cell division to result in growth. Similar results were reported by Tuller et al. (2014) stated that the sulphate in fucoidan binds to the myosin complex, which causes cell division to increase body mass and muscle fibre size. Canciyal et al. (2016), also reported that giving a fucoidan diet as much as 3% kg^{-1} of feed could increase the weight growth of giant prawns. Fabrini et al. (2017) reported that the sulphated polysaccharide fucoidan, used in diets for *Oreochromis niloticus* with 30 days of rearing, was not effective in increasing performance parameters and muscle growth.

Apart from fucoidan, turmeric extract is known to promote growth. The content of curcumin and essential oils in turmeric can increase appetite in fish and function as antioxidants (Prabowo et al., 2017). The same thing was reported by Insana & Wahyu (2015), that curcumin and essential oils in turmeric could affect the pancreas to secrete enzymes and accelerate gastric emptying so that appetite increases. Curcumin is known to stimulate the gallbladder wall to secrete bile and stimulate the pancreas to secrete enzymes to increase the body's metabolism(Arifin et al., 2015).

An increase in length generally accompanies weight gain because growth indicators are weight and length gain. The results of this study indicate that fucoidan supplementation with turmeric extract can significantly the growth of African catfish. The same result was reported by Puspitasari (2017); the rate of weight gain was directly proportional to the rate of increase in length in African catfish that were given herbal supplements through the feed. A diet combination of fucoidan and turmeric increased SGR significantly ($p < 0.05$). The same study results were reported by Purbomartono et al. (2019); giving fucoidan as a supplement through feed at a dose of 4000 mg kg^{-1} of feed can significantly increase the SGR of African catfish by 3.33% (g / d). Prabu et al. (2016) reported that *P. hypothalamus* fish seeds given fucoidan increased weight percentage gain and SGR. Fucoidan is a sulphated polysaccharide and contains several essential elements that support growth.

In addition to the function and role of fucoidan in increasing the growth of SGR, it is also because of the stimulant that is carried out due to the administration of turmeric supplements. It was as reported by Kusumah (2018) that turmeric flour can increase good microorganisms in the digestive tract to increase microbial activity, which leads to optimal absorption of nutrients. Furthermore Cahyani et al. (2021), reported that red tilapia given turmeric flour supplements could increase growth such as increasing the SGR and the survival percentage could reach above 80%. Turmeric (*Curcuma domestica* Val) is a spice and medicinal plant from Southeast Asia that can be used as a feed additive because it is easily obtained at low prices and contains curcumin essential oil. One way to increase feed efficiency is to add feed additives to the feed. Turmeric flour can be used as a feed additive because it can stimulate appetite (Nova et al., 2015). The curcumin in turmeric works to increase palatability, thereby stimulating the fish's appetite, which results in increased growth. In addition, curcumin can increase the body's resistance of fish, so that indirectly with a healthy fish condition, the fish's appetite will increase, which has an impact on the weight of the fish (Cahyani et al., 2021).

Feed Conversion Rate (FCR) and Feed Efficiency (FE)

Feeding with the addition of Sargassum extract can optimize feed utilization and nutrient absorption, as evidenced by the low feed conversion rate (Mulyadi et al., 2020). The same report Traifalgar et al. (2009) reported that the fucoidan diet could reduce the feed conversion rate value of vanamei shrimp (*Litopenaeus vanamei*) at a dose of 500 mg kg^{-1} feed. A low feed conversion rate indicates that dietary fucoidan could increase optimal growth compared to control. This is supported by Traifalgar et al. (2009), dietary fucoidan can also increase phagocytosis activity to reduce stress on pathogenic bacteria and the environment so that it can improve growth. Further, previous research conducted by Mulyadi et al. (2020) stated that giving fucoidan at a dose of 2000 mg kg^{-1} of feed could increase SGR in vanamae shrimp by 1.39.

Fucoidan supplementation in shrimp feed for 30 days gave good feed conversion results with high survival rates (86-92%) (Pratiwy et al., 2020). Traifalgar et al. (2009) successfully examined that use 500-2000 mg / kg capable shrimp feed increase biomass, efficiency ratio protein, FCR which low and has a high survival. Fucoidan supplementation also did not cause changes in protein, fat, and other body components (Traifalgar et al., 2009). The given fucoidan is also useful as a cytoprotector against the gastric mucosal epithelium and increases the production of growth factors (Li et al., 2008).

Tabel 2. Measurements of the FCR, FE and Feed intake of catfish

Parameters	***Experimental group***		
	A (control)	**B**	**C**
FCR	4.06^{a}	2.58^{b}	2.72^{b}
Feed Eficienc	24.65^{a}	38.76^{b}	36.81^{b}
Feed Intake	385.28	394.21	399.97

Based on the results of the study, it was shown that the combination diet of dit fucoidan with turmeric could significantly increase growth in WG, Lt and SGR parameters (Table 1). This combination indicates that the addition of feed with fucoidan and turmeric is more recommended than fucoidan alone. The dose of fucoidan was reduced and then substituted with turmeric. Turmeric is easier to obtain, available in the market at a relatively cheap price. Meanwhile, brown seaweed has a limited source of material, it is found on the coast where the population is limited and depends on the season and sea waves. Similarly, extraction from turmeric is easier and cheaper than the extraction of fucoidan from the more expensive brown seaweed.

The results of the FCR and FE studies (Table 2), in addition to the role and function of fucoidan, are also due to the greater role and function of turmeric. Both at doses B (400 mg fucoidan +1350 mg turmeric) and C (800 mg fucoidan +1.200 mg turmeric) the percentage of turmeric in the combination was higher than fucoidan. Several results has an important role and function in reducing feed conversion and increasing feed efficiency. Several previous studies have shown Ram Prakash Raman et al. (2017) that giving a diet of turmeric extract to Cirrhinus mrigala fish can reduce FCR and increase the value of feed efficiency. Low FCR is usually accompanied by high feed efficiency. Afifah et al. (2021) reported, giving 1% turmeric extract to gourami was known to be effective as an attractant and can increase fish growth, the lowest conversion ratio value, and the highest utilization efficiency.

The diet of turmeric can increase feed efficiency, and it is proven that the diet of turmeric at a dose of 1.500 mg kg^{-1} of feed can increase efficiency to 2.81% compared to the control of 2.44% (Purbomartono et al., 2021). Turmeric also plays a role in increasing feed efficiency; giving a dose of 1,500 g kg^{-1} of feed can increase to 2.81% compared to control 2.44% (Purbomartono et al., 2021). In general, the herbal diet is reported to improve digestive performance by stimulating the secretion of enzymes that can increase digestibility, stimulate appetite and increase food consumption so that growth is better (El-Desouky et al., 2012). The value of good feed efficiency can be caused by the type of feed ingredients that are easily digested. The essential oil in turmeric can prevent the release of excess stomach acid, thus facilitating the absorption of nutrients (Putri et al., 2016 *in* Cahyani et al., 2021).

7. CONCLUTION

Dietary fucoidan with turmeric in catfish can significantly increase weight and length gain (WG & LG), daily or specific growth rate (SGR), FCR, and feed efficiency (FE). Dietary fucoidan with turmeric at a dose (1200 mg fucoidan + 1050 mg extract turmeric) kg^{-1} feed (D) has the potential to be used in fish farming, especially in catfish.

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