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Evaluation of fermented rice bran to replace soybean meal in the diet of *Clarias* sp. fingerling

Evaluasi fermentasi dedak padi untuk menggantikan tepung kedelai pada pakan benih ikan lele *Clarias* sp

Achmad Noerkhaerin Putra[1,2*], Mas Bayu Syamsunarno[1], Dede Rohayati[1], Yuhana Marta Sarah[1], Ghulam Abdul Matien[1]

[1]Department of Fisheries Science, Faculty of Agriculture, Universitas Sultan Ageng Tirtayasa, Jl Raya Palka KM.04, Sindangsari, Serang, Banten 42163, Indonesia
[2]Indonesian Center of Excellence Local Food Innovation, Universitas Sultan Ageng Tirtayasa Jl Raya Palka KM.04, Sindangsari, Serang, Banten 42163, Indonesia
*Corresponding author: putra.achmadnp@untirta.ac.id

ABSTRACT

Rice bran is being fermented using *Aspergillus niger* in order to increase its usage as a raw material for the catfish diet. This research aims to evaluate the potentials of rice bran fermented with *A. niger* to replace soybean meal in catfish *Clarias* sp diet. There were two research stages, first the fermentation test of *A. niger* on rice bran that used a completely randomized factorial design consisting of 2 factors, namely the dose of *A. niger* (0, 0.5, 1, 1.5, and 2 g/100 g) and incubation time (0, 24 and 48 hours). Secondly, the substitution test of soybean meal with fermented rice bran on five different of substitution levels (0, 15, 20, 35, and 40%) in the catfish diet. The results showed that the fermentation of *A. niger* of 2 % with an incubation period of 24 hours in rice bran resulted in the smallest crude fiber and fraction content, and increased protein and amino acid including serine, threonine, alanine, methionine, isoleucine, and lysine. The specific growth rate in the substitution treatment of 0-20% was significantly (P<0.05) higher than that of 35-40%. There was also no difference (P>0.05) in the growth performance of catfish in the 0 to 20% substitution treatment. Also, replacing soybean meal with fermented rice bran up to 20% did not have a negative effect on the growth performance of catfish. It was concluded that fermented rice bran could be used as raw material for catfish.

Keyword: *Aspergillus niger*, catfish, fermentation, rice bran

ABSTRAK

Fermentasi dedak padi dengan menggunakan kapang *Aspergillus niger* adalah upaya yang dapat dilakukan untuk meningkatkan pemanfaatan dedak padi sebagai bahan baku pakan ikan lele. Penelitian ini bertujuan untuk mengevalusi potensi dedak padi yang difermentasi *A. niger* untuk menggantikan tepung kedelai pada pakan ikan lele Clarias sp. Penelitian ini terdiri dari 2 tahapan penelitian, pertama: uji fermentasi *A. niger* pada dedak padi yang menggunakan rancangan acak lengkap faktorial yang terdiri dari 2 faktor, yaitu dosis *A. niger* (0, 0.5, 1, 1.5, dan 2 g/100 g) dan lama inkubasi (0, 24 dan 48 jam). Kedua: uji subtitusi tepung kedelai dengan dedak padi terfermentasi dengan 5 level subtitusi tepung kedelai berbeda (0, 15, 20, 35 dan 40%) dengan dedak terfermentasi dalam pakan ikan lele. Hasil penelitian menunjukkan fermentasi *A. niger* dengan dosis 2% dengan lama inkubasi 24 jam menghasilkan nilai serat kasar dan fraksi serat kasar terkecil dan meningkatkan kandungan protein dan asam amino (serin, threonine, alanine, methionine, isoleusin dan lisin) pada dedak padi. Nilai specific growth rate pada perlakuan subtitusi 0-20% secara signifikan (P<0.05) lebih tinggi dibandingkan dengan perlakuan subtitusi 35-40%. Tidak terdapat perbedaan (P>0.05) nilai kinerja pertumbuhan ikan lele pada perlakuan subtitusi 0-20%. Subtitusi tepung kedelai dengan dedak padi terfementasi hingga level 20% tidak berdampak negatif terhadap kinerja pertumbuhan ikan lele. Dedak padi terfermentasi berpotensi digunakan sebagai bahan baku ikan lele.

Kata kunci: *Aspergillus niger*, dedak padi, fermentasi, ikan lele

INTRODUCTION

Catfish (*Clarias* sp.) is a freshwater commodity with high economic value (Dewi *et al.,* 2016; Iswanto *et al*., 2019). Therefore, intensive farming with a high density and diet has been carried out to fulfill its increasing demand (Putra *et al*., 2021). Artificial diet is one of the determining factors in the production level of intensive farming and the most expensive component that spends 50 to 60% of production costs (Abidin *et al*., 2015). According to Ngaddi *et al*., (2019), one of the problems faced in intensive freshwater fish farming, including catfish, is the high price of artificial diet. It is caused by the increase in the price of protein sources. The sources of protein raw materials such as fish and soybean meals are increasingly limited (FAO, 2018). Therefore, alternatives are needed to reduce imported raw materials such as soybean meal in the catfish diet

Rice bran is one of the local raw materials that can be used as an alternative protein source due to its good nutritional content, inexpensive price, and abundance (Yanto *et al*., 2018; Surianti *et al*., 2021). It contains 11.19% crude protein, 9.15% crude lipid, 9.17% ash and 31.04% crude fiber (Muin *et al*., 2013). However, rice bran as a raw material for fish diet is limited by its high crude fiber content (Ikhwanuddin *et al*., 2018) and the presence of anti-nutritional substances in the form of trypsin inhibitors and phytic acid (NRC 2011). Rice bran is a by-product from rice milling (Samuel & Shapawi, 2016) which contains hemicellulose of 8.7-11.4% and cellulose of 9.0-12.8% (Sansuwan *et al*., 2014). According to Nates (2016), rice bran is limited to 10 to 20% of the total fish diet formulation. Therefore, an effort is needed to reduce crude fiber and anti-nutritional substances.

Fermentation is one of the processes used to reduce the crude fiber and anti-nutrients in a material (Helmiati *et al*., 2018). It has been used to improve the quality of fish feed raw materials (Rostika *et al*., 2017; Mulyasari *et al*., 2018; Aslamyah *et al*., 2017 & 2019). This process increases nutrition through the biosynthesis of vitamins, essential amino acids, and protein as well as improving protein quality and reducing crude fiber (Putra *et al*., 2018). According to Chinma *et al*. (2014), the nutritional quality of rice bran can be improved by fermentation. *A. niger* is one of the mold species that is often used in the fermentation process of fish diet raw materials, moringa leaf meal in the tilapia diet (Putra *et al*., 2018). It is also used in the fermentation of jatropha concentrate in the Labeo rohita fish diet (Shanma *et al*., 2015), Jatropha curcas meal in Labeo rohita fish seed diet (Phulia *et al*., 2017), groundnut oil cake in vaname shrimp diet (Jannathulla *et al*., 2018a), and soybean meal in white shrimp diet (Jannathulla *et al*., 2018b). Based on the description above, this research aims to evaluate the potential of rice bran fermented with *A. niger* to replace soybean meal in the catfish (*Clarias sp.*) diet.

MATERIALS AND METHODS

Fermentation Test of *A. niger* on Rice Bran

Fermentation test was carried out to obtain the best combination of *A. niger* dose and incubation time in reducing the crude fiber in rice bran. In previous study, we found that the dose of *A.niger* (0.5 and 1.5 g/100 g) were able to reduce crude fiber of rice bran. Therefore, in the present study we used a wider range of *A. niger* doses to obtain a more precise dose to reduce the crude fiber content of rice bran. A completely randomized factorial design consisting of 2 factors, namely the dose of *A. niger* (0, 0.5, 1, 1.5, and 2 g/100 g) and fermentation time (0, 24 and 48 hours) was used in this test. The factorial design used refers to Putra *et al*. (2020) who used a factorial design to evaluate the effect of 2 factors on the crude fiber content of moringa leaves meal. A total of 1 kg of rice bran was steamed at 60°C for 30 minutes. Furthermore, the rice bran was mixed with *A. niger* and distilled water of about 30%. Then rice bran was incubated according to the required time for incubation. The rice bran was analyzed proximately to evaluate the crude fiber in each treatment. Crude fiber fractions, including Neutral Detergent Fiber (NDF), Hemicellulose, Acid Detergent Fiber (ADF), and Cellulose and amino acid were measured to determine the effect of *A. niger* fermentation on the nutrition of rice bran.

Substitution Test of Soybean meal with Fermented Rice Bran

The test diet was made with a target of 30% protein and 8% lipid according to the nutritional needs of catfish. Rice bran was fermented by *A. niger* with the best dose and incubation time. All raw materials, including fermented rice bran were sifted to obtain fine materials. Afterward, it was weighed according to the required proportions in the test diet formulation for each treatment (Table 1). After all the materials were stirred and mixed well, about 40% of hot water at 70° C was added and then stirred again until smooth. The mixture was then put into a pellet press machine and then baked at a temperature of 60°C for 24 hours. The diet was stored in a dry and clean place with sufficient air circulation until it was ready to be given to the fish.

A completely randomized design was used along with five substitution treatments for soybean meal using fermented rice bran (0, 15, 20, 35, and 40%) and three replications. The treatments were determined based on Yanto *et al*. (2018) and Surianti *et al*. (2020). The test fish used were catfish obtained from the Baros Seed Center, Serang Regency, Indonesia. They had an average weight of 4.48 ± 0.03 g/fish and were kept in containers with a volume of 40 liters of water and a density of 15 fish/container for 50 days. It was adapted first by being given a commercial diet for seven days. After the adaptation period was complete, the fish were not fed for 24 hours to remove the remaining diet in their digestive system. Furthermore, during the rearing period, they were fed at satiation twice a day at 08.00 and 16.00. Also, 25 to 75% of the water was changed every 7 days depending on the condition of the container. To determine water quality during the rearing, water quality measurements were carried out using the following parameters, namely temperature, pH, dissolved oxygen, and ammonia at the beginning, middle, and end of the research. It was shown that, during rearing, the water quality was still in the normal range with a temperature of 26.2 to 27.5° C, pH 7, and DO 3.1 to 4.6 mg/L, while the ammonia values range from 1.2 to 3.7 mg/L.

Research Parameters and Chemical Analysis

At the end of rearing, the fish growth parameters consisting of total diet consumption, feed conversion, specific growth rate, protein efficiency ratio and survival rate were calculated based on the formula proposed Wu *et al*., (2020). Proximate analysis including the value of protein,

Table 1. Proximate composition of the test diet.

	Test Diet (%)				
Composition	0	15	20	35	40
Fermented rice bran	0.00	3.75	5.00	8.75	10.00
Soybean meal	25.00	21.25	20.00	16.25	15.00
Fish meal	200.0	20.00	20.00	20.00	20.00
Bone and meat meal	8.50	9.18	94.00	10.80	10.30
Tapioca meal	17.10	17.36	17.58	17.71	15.46
Polar meal	19.70	18.11	17.45	15.99	17.80
Fish oil	2.50	2.13	1.72	1.63	1.44
Palm oil	2.00	1.79	2.00	1.51	1.50
Vitamin and mineral mix	3.60	3.60	3.60	3.60	3.60
Chlorine chloride	0.05	0.05	0.05	0.05	0.05
Vitamin C	1.00	1.00	1.00	1.00	1.00
Casein	0.05	1.29	1.70	2.94	3.35
Lysine+methionine	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100
Results of Proximate Analysis					
Crude protein	30.82	30.82	30.68	30.81	30.38
Crude lipid	8.44	8.51	8.54	8.60	8.02
Crude fiber	4.41	4.47	4.23	4.54	4.79
NFE*	39.9	39.53	40.43	39.05	42.17
Energy (Kcal/kg)**	275.98	275.63	277.63	275.12	276.72
Energy/protein	8.95	8.94	9.05	8.93	9.11

* nitrogen-free extract material (100-content proximate materials)

** Digestible energy, obtained from energy conversion (protein: 3.5 kcal DE, lipid: 8.1 kcal DE, NFE: 2.5 kcal DE) lipid, ash and water content, and crude fiber in diet and fish was carried out according to the procedure referred to AOAC (1999). Furthermore, the analysis of crude fiber fraction in rice bran before and after *A. niger* fermentation was calculated based on the method described by Van Soest (1963). The amino acid in rice bran was analyzed using AOAC (1995) method with high-performance liquid chromatography (HPLC).

Statistic Analysis

The data obtained were analyzed using analysis of variance (ANOVA) with a 95% confidence interval. Duncan's further test using SPSS 17 was carried out when different responses were obtained between treatments.

RESULTS AND DISCUSSION

Rice bran Fermentation Test

Crude fiber values of fermented rice bran with different doses of *A. niger* and the period of incubation are presented in Table 2. The crude fiber at 0 hours ranged from 9.00 to 10.66%. However, there was no difference (P>0.05) in the crude fiber at 0% of *A. niger* dose starting from 0 to 48 hours incubation time. The decrease in crude fiber value occurred at doses of 0.5 to 2% ranging from 0 to 48 hours. Meanwhile, the decrease in crude fiber value significantly (P<0.05) began to occur at the incubation time of 24 hours which ranged from 5.17 to 10.66%, and 48 hours ranging from 4.60 to 10.66%.

The crude fiber fraction values of NDF, hemicellulose, ADF, and cellulose in rice bran are presented in Table 3. The results show that the highest value of crude fiber fraction significantly (P<0.05) is in the treatment of unfermented rice bran. The NDF values obtained ranged from 42.28 to 52.49%. Furthermore, the hemicellulose and ADF values ranged from 30.05 to 38.08% and 12.43 to 17.28%, respectively. Meanwhile, the value of cellulose varied between 6.37 to 6.59%. The nutrition and amino acids of rice bran are presented in Table 4. The results show that the protein of fermented rice bran was significantly (P<0.05) higher than that of unfermented. Furthermore, the protein values obtained ranged from 16.95 to 20.13%. Fermented rice bran also had higher amino acids, namely serine, threonine, alanine, methionine, isoleucine, and lysine (P<0.05) compared to unfermented ones.

Table 2. Crude fiber values of fermented rice bran *A. niger* with different doses and incubation times*.

	A. niger dose (g/100 g)				
Incubation time (hours)	0	0.5	1	1.5	2
0	10.66 ± 0.06^{c} A	8.28 ± 0.17^{a} C	9.49 ± 0.56^{b} B	9.44 ± 0.08^{b} C	9.00 ± 0.84^{ab} B
24	10.66 ± 0.06^{c} A	7.25 ± 0.30^{b} B	7.67 ± 1.72^{b} AB	7.60 ± 0.28^{b} B	5.17 ± 0.56^{a} A
48	10.66 ± 0.06^{d} A	6.55 ± 0.35^{b} A	7.16 ± 0.33^{c} A	6.64 ± 0.33^{bc} A	4.60 ± 0.39^{a} A

*Note:
The average crude fiber ±SE followed by different superscript letters show significantly different values (P<0.05). Factorial randomized design consisting of *A. niger* dose and incubation time. Superscript letters "a, b, c" are read horizontally while superscript letters "A, B, C" are read vertically.

Table 3. Value of crude fiber fraction of fermented rice bran *A. Niger**.

	Fermented rice bran		
Crude fiber fraction	No fermentation	*A. niger* dose of 2% and incubation time of 24 hours	*A. niger* dose of 2% and incubation time of 48 hours
NDF (%)	52.49 ± 1.29^{b}	42.89 ± 2.21^{a}	42.28 ± 2.03^{a}
Hemicellulose (%)	38.08 ± 0.18^{b}	30.88 ± 0.14^{a}	30.05 ± 0.64^{a}
ADF (%)	17.28 ± 0.11^{c}	12.43 ± 0.16^{b}	12.65 ± 0.17^{b}
Cellulose (%)	8.72 ± 0.1^{b}	6.59 ± 0.13^{a}	6.37 ± 0.17^{a}

*Note:
The average crude fiber ±SE followed by different superscript letters on the same line show significantly different values (P<0.05). NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber

Catfish Growth and Survival Rate

The catfish growth at the substitution of soybean meal with rice bran is presented in Table 5. At the end of rearing, the substitution did not significantly affect the total diet consumption and survival rate after feeding for 50 days (P>0.05). Meanwhile, the final biomass value, feed conversion, protein efficiency ratio, and specific growth rate in the 0 to 20% substitution treatment were significantly (P<0.05) higher than that of 35 to 40%. The highest specific growth rate was found in the 15% substitution treatment at 2.70, followed by the 0%, 20%, and 35% substitution treatment at 2.59%/day, 2.45%/day, and 1.75%/day. Also, the smallest value was found in the 40% substitution treatment by 1.47%/day.

Table 4. The nutritions and amino acid of rice bran fermented with *A. niger**.

	Fermented rice bran		
Nutritional content	No fermentation	*A. niger* dose of 2% and incubation time of 24 hours	*A. niger* dose of 2% and incubation time of 48 hours
Proteins (%)	16.95 ± 0.07[a]	19.90 ± 0.42[b]	20.13 ± 0.88[b]
Lipid (%)	4.51 ± 0.01	4.47 ± 0.03	4.49 ± 0.02
Water content (%)	10.80 ± 0.35	10.75 ± 0.35	10.55 ± 0.04
Aspartic Acid (%)	0.9 ± 0.04	1.01 ± 0.03	1.04 ± 0.09
Glutamic Acid (%)	1.44 ± 0.05	1.65 ± 0.18	1.64 ± 0.12
Serine (%)	0.37 ± 0.02[a]	0.50 ± 0.00[b]	0.47 ± 0.06[ab]
Glycine (%)	0.30 ± 0.02	0.35 ± 0.03	0.34 ± 0.01
Histidine (%)	0.38 ± 0.02	0.40 ± 0.01	0.41 ± 0.01
Arginine (%)	0.43 ± 0.00	0.43 ± 0.03	0.43 ± 0.01
Threonine (%)	0.41 ± 0.03[a]	0.51 ± 0.01[b]	0.50 ± 0.01[b]
Alanine (%)	0.52 ± 0.02[a]	0.59 ± 0.01[b]	0.60 ± 0.07[b]
Proline (%)	0.29 ± 0.06	0.33 ± 0.06	0.31 ± 0.02
Tyrosine (%)	0.26 ± 0.04	0.25 ± 0.05	0.25 ± 0.01
Valine (%)	0.67 ± 0.04	0.68 ± 0.04	0.66 ± 0.07
Methionine (%)	0.41 ± 0.02[a]	0.51 ± 0.01[b]	0.48 ± 0.04[b]
Cysteine (%)	0.29 ± 0.01	0.34 ± 0.04	0.33 ± 0.02
Isoleucine (%)	0.36 ± 0.02[a]	0.43 ± 0.03[b]	0.42 ± 0.01[ab]
Leucine (%)	0.72 ± 0.02	0.74 ± 0.04	0.76 ± 0.07
Phenylalanine (%)	0.55 ± 0.04	0.62 ± 0.01	0.60 ± 0.04
Lysine (%)	0.45 ± 0.01[a]	0.55 ± 0.03[b]	0.56 ± 0.04[b]

*Information: The average ±SE followed by different superscript letters shows significantly different values (P<0.05).

Table 5. Catfish growth at the substitution of soybean meal with fermented bran in diet*.

	Substitution of soybean meal with rice bran in diet (%)				
Parameter	0	15	20	35	40
Initial weight (g)	4.73 ± 0.05	4.73 ± 0.05	4.73 ± 0.05	4.78 ± 0.03	4.80 ± 0.05
Final biomass (g)	225.00 ± 9.54[b]	239.33 ± 6.03[b]	214.33 ± 8.62[b]	158.33 ± 16.50[a]	141.67 ± 29.67[a]
Total Diet Consumption (g)	179.67 ± 7.09	189.00 ± 5.57	158.33 ± 16.50	182.67 ± 9.07	185.67 ± 14.57
Feed conversion	1.17 ± 0.10[a]	1.12 ± 0.03[a]	1.28 ± 0.11[a]	2.17 ± 0.48[ab]	2.98 ± 1.13[b]
Protein efficiency ratio (%)	2.80 ± 0.24[b]	2.89 ± 0.09[b]	2.61 ± 0.22[b]	1.57 ± 0.37[a]	1.24 ± 0.53[a]
Specific growth rate (%/day)	2.59 ± 0.09[b]	2.70 ± 0.03[b]	2.45 ± 0.12[b]	1.75 ± 0.25[a]	1.47 ± 0.45[a]
Survival rate (%)	100.00 ± 0.00	97.78 ± 3.85	97.78 ± 3.85	97.78 ± 3.85	100 ± 0.00

*Note: The average ±SE followed by different superscript letters shows significantly different values (P<0.05).

Catfish Body Composition

After the period of rearing was over, there was no difference (P>0.05) in the protein and lipid composition in the catfish body as shown in Table 6. The protein ranged from 12.14 to 12.39%, while the lipid was 3.20 to 3.29%.

Discussion

The fish diet raw materials derived from plants act as a source of crude fiber and when a high amount is being consumed it affects the digestibility and growth (Hansen & Hemre, 2013) of fishes. A crude fiber consisting of cellulose, hemicellulose, and lignin is an invaluable material in the nutrition of carnivorous fish (Bonvini *et al*., 2018). The results in Table 2 show that the fermentation with *A. niger* in rice bran reduced the crude fiber by 43%. The best decrease was found in the 2% dose with an incubation period of 5.17% for 24 hours and 4.60% for 48 hours. According to NRC (2011), the maximum crude fiber in the diet should be no more than 10%. The value of 5.17% in the combination treatment of 2% *A. niger* dose and 24 hours incubation time was in the range of the crude fiber content recommended by the NRC.

According to Melati & Sunarno (2016), crude fiber fraction (NDF, hemicellulose, ADF, cellulose, lignin) affects the ability of animals to absorb food. Based on Table 3, there was a significant (P<0.05) decrease in the crude fiber fraction, namely 19% NDF, 18.9% hemicellulose, 28% ADF, and 24% cellulose in fermented rice bran compared to the unfermented. Therefore, this indicates that *A. niger* fermentation reduced the crude fiber of rice bran. Shi *et al*. (2015) also reported that the decrease in crude fiber after the fermentation process is caused by the fibrinolytic enzymes produced by microorganisms. Meanwhile, according to Kang *et al*. (2004), *A. niger* produces fiber-degrading enzymes such as cellulase and hemicellulase. Previous research reported that the fermentation of *A. niger* on soybean and guar meals (Jannathulla et al. 2017a) and rapeseed meal (Jannathulla *et al*., 2018a) as diet raw materials for *Penaeus vannamei*, causes a significant decrease (P<0.05) in NDF, hemicellulose, ADF, and cellulose compared to that without fermentation. Pangestika & Putra (2018) has reported that fermentation wheat bran using *A. niger* increase crude protein and reduce crude fiber content.

The quality of protein in a fish diet is determined by the amount and proportion of amino acids that impact on growth and production costs (Zehra & Khan, 2014). Besides its importance for the synthesis of proteins and other nitrogen, it also plays a role in the main metabolic processes of fish (Jobgen *et al*., 2006). According to NRC (2011), amino acid deficiency leads to decreased growth, poor diet conversion, and disease susceptibility. The results showed that the fermentation with *A. niger* significantly (P<0.05) increased the protein and limited amino acids such as lysine and methionine in fish. This confirmed the research by Jannathulla *et al*., (2017b) that *A. niger* fermentation increases protein and methionine in guar meal. Furthermore, these results also indicate that it is capable of degrading protein in rice bran. Anwar *et al*. (2020) stated that *A. niger* secretes various enzymes such as xylanase, cellulase, amylase, protease, and other bioactive compounds capable of degrading crude fiber and protein. It was also reported to be capable of producing phytase (Casey & Walsh, 2003), and proteases (Koedprang & Charoendat, 2019). The results also implied no difference (P>0.05) in crude fiber and its fraction between *A. niger* 2% treatment with 24 and 48 hours incubation. Therefore, this combination was used for the preparation of the diet test. There was no difference (P<0.05) in lipid in each treatment in this research. This indicated that the fermentation with *A. niger* could not degrade the lipid contained in the rice bran. Similar results were also reported by Jannathulla *et al*. (2018b) in which there was no difference in lipid between the diet raw materials, namely soybean meal and sunflower oil cake fermented

Table 6. Body composition of catfish in the substitution of soybean meal with fermented bran in diet*.

	Substitution of soybean meal with rice bran in diet (%)				
Parameter	0	15	20	35	40
Initial protein	11.12 ± 0.01	11.12 ± 0.01	11.12 ± 0.01	11.12 ± 0.01	11.12 ± 0.01
Final protein	12.26 ± 0.29	12.39 ± 0.48	12.23 ± 0.23	12.24 ± 0.21	12.14 ± 0.15
Initial lipid	2.02 ± 0.01	2.02 ± 0.01	2.02 ± 0.01	2.02 ± 0.01	2.02 ± 0.01
Final lipid	3.27 ± 0.40	3.20 ± 0.29	3.27 ± 0.02	3.29 ± 0.39	3.22 ± 0.20

*Note: The average ±SE followed by different superscript letters shows significantly different values (P<0.05).

with *A. niger* and the one without fermentation.

Furthermore, there was no difference (P>0.05) in total diet consumption between the control and the substitution treatment of 15 to 40%. This indicated that substituting soybean meal with fermented rice bran had no adverse effect on catfish appetite. Li *et al*., (2017) also found that the substitution of soybean meal in the diet formulation results in a total consumption that does not differ between treatments in the rearing of hybrid catfish. Moreover, Koedprang & Charoendet (2019) also discovered that the supplementation of *A. niger* fermented soybean meal in diet formulation does not affect the total consumption of Asian seabass juveniles. Nates (2016) stated that, physical parameters such as color, texture, density, odor, and shape, as well as chemical parameters including attractability are factors affecting diet palatability.

The results showed that the higher the soybean meal substitution with fermented rice bran, the more the negative effect on the final biomass value, diet conversion, protein efficiency ratio, and specific growth rate of catfish whereby the substitution level of 35 to 40% was smaller than those at 0 to 20%. This was presumably because of the lack of amino acid with a substitution level of 35 to 40%, which negatively affected the growth of catfish. Hence, fermented rice bran could not replace soybean meal at higher levels (20%). Similar results were also obtained by Su *et al.* (2019) whereby the substitution of soybean meal with that of cottonseed at a higher level (100%) results in a lower specific growth rate in common carp fish compared to the control. Wang *et al*., (2020) also revealed that the substitution of soybean meal with cottonseed meal at a level > 87.44% has a negative effect on the growth of juvenile white shrimp. Similar results have also been uncovered in several fish species, such as black carp (Hu *et al*., 2015) and jelawat (Yanto *et al*., 2018). There was no effect of soybean meal substitution with fermented rice bran on the survival rate of catfish at the end of the research. This indicated that the use of fermented rice bran in the diet did not affect the catfish physiological processes. Similar results have also been demonstrated in several aquaculture commodities, such as hybrid catfish (Li *et al*., 2017), *Penaeus vannamei* (Jannathulla *et al*., 2018b, Jannathulla *et al*., 2018a, Jannathulla *et al*., 2019, Dayal *et al*., 2020) and Juvenile Asian Seabass (Koedprang & Charoendet, 2019).

At the end of rearing, the body composition of catfish showed no difference between treatments. This indicated that the use of fermented rice bran did not affect the body composition of catfish proximate at the end of rearing. The results reported by Novriadi *et al*., (2018) showed that the substitution of soybean meal with the one that was already fermented in diet formulations does not affect the protein and lipid proximate composition of *Florida pompano* fish. The same result was also confirmed by Diogenes *et al*., (2019) where the use of distillers dried grains with soluble (DDGS) to replace soybean meal in the diet test did not affect the final protein and lipid of gilthead seabream fish.

CONCLUSION

Fermentation of *A. niger* in rice bran was could reduce the crude fiber content and fraction, namely NDF, hemicellulose, ADF, and cellulose. Furthermore, the dose of 2% with an incubation period of 24 hours resulted in the smallest crude fiber and its fraction as well as increased protein and amino acid (lysine and methionine) in rice bran. The higher the substitution (35-40%) produced, the more the negative effect on the growth performance of catfish. It was also confirmed that the fermented rice bran could replace soybean meal in catfish diet formulations with as much as 20%.

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REFERENCES

Abidin Z, Junaidi M, Paryono, Cokrowati N, Yuniarti S. 2015. The growth and feed consumption of walking catfish fed diets with local ingredient. Jurnal Ilmu Ilmu Perairan, Pesisir dan Perikanan 4: 33–39.

[AOAC] Association of Official Analytical Chemists.1995. Official methods of analysis of AOAC international. 16th edition. USA: Association of Analytical Communities, Arlington.

[AOAC] Association of Official Analytical

Chemists. 1999. Official methods of analysis of the association of official analytical of chemist. Arlington, Virginia, USA: Published by the Association of official analytical chemist, Inc.

Anwar A, Wan AHL, Omae S, El-Haroun E, Davies S. 2020. The potential of a solid-state fermentation supplement to augment white lupin (*Lupinus albus*) meal incorporation in diets for farmed common carp (*Cyprinus carpio*). Aquaculture Reports 17: 100348.

Aslamyah S, Karim MY, Badraeni. 2017. Fermentation od seaweed flour with various fermenters to improve te quality of fish feed ingredients. Jurnal Akuakultur Indonesia 16: 8–14.

Aslamyah S, Zaisuddin, Badraeni. 2019. The effect of supplementation of *Lumbricus* sp. In fermented foods for growth performance, body chemical composition and hepatosomatic index of milkfish, *Chanos chanos* Forsskal, 1775. Jurnal Iktiologi Indonesia 19: 271–282.

Bonvini E, Bonaldo A, Parma L, Mandrioli L, Sirri R, Grandi M, Fontanillas R, Viroli C, Gatta PP. 2018. Feeding European sea bass with increasing dietary fibre levels: impact on growth, blood biochemistry, gut histology, gut evacuation. Aquaculture 494: 1–9.

Casey A, Walsh G. 2003. Purification and characterization of extracellular phytase from *Aspergillus niger* ATTCC 9142. Bioresource Technology 86: 183–8.

Chinma Cf, Ilowefah M, Muhamad K. 2014. Optimum of rice bran fermentation condition enhanced by Baker's yeast fr extraction of protein concentrate. Nigerian Food J 32: 126–132.

Dayal JS, Jannathulla R, Ambasankar K, Muralidhar M. 2020. *Aspergillus niger* fermented plant protein mix as a potential substitute for fishmeal in the diet of *Penaeus vannamei* (Boone 1931). Aquaculture Nutrition 26: 853–865.

Dewi RRSPS, Iswanto B, Insan I. 2016. Productivity and profitability of improved and non-improved strains of African catfish (*Clarias gariepinus*) farming rearing in earthen pond. Media Akuakultur 11: 11–17.

Diogenes AF, Basto A, Tassia, Rodrigues-Estevao, Moutinho, Aires T, Oliva-Teles A, Peres H. 2019. Soybean meal replacement by corn distillers dried grains with solubles (DDGS) and exogenous non-strach polysaccaridases supplementation in doets for gilthead seabream (*Sparus aurata*) juveniles. Aquaculture 500: 435–442.

Food and Agriculture Organization of the United Nations (FAO). 2018. The State of World Fisheries and Aquaculture*: Opportunities and Challenges*. Roma: FAO. 223 pp.

Hansen AC, Hemre GI. 2013. Effect of replacing fish meal and oil with plant resources in on-growing diets for Atlantic cod (*Gadus morhua* L.) Aquaculture Nutrition 19: 641–650.

Helmiati S, Rustadi R, Isnansetyo A, Zuprizal Z. 2018. An evaluation of nutrient value and antinutritional contents of fermented *Moringa oleifera* leaves meal as fish feed ingredient. Jurnal Perikanan UGM 22: 149–158.

Hu Y, Huang Y, Feng F, Zhong L, Ai Q, Xiao T, Wen H. 2015. Effect of soybean meal replacement by cottonseed meal on growth, feed utilization and some blood physiological/ biochemical indices of juvenile black carp, *Mylopharyngodon piceus*. Aquaculture Research 46: 2490–2500.

Ikhwanuddin M, Putra AN, Mustahal. 2018. Utilization of rice brand fermentation with *Aspergillus niger* on feed raw material of tilapia (*Oreochromis niloticus*). Jurnal Perikanan dan Kelautan 8: 79–87.

Iswanto B, Suprapto R, Imron. 2019. Establishing a base population of individual selection for low maintenance requirements in term of dietary protein level in the African catfish (*Clarias gariepinus*). Indonesian Aquaculture Journal 14: 23–29.

Jannathulla R, Dayal JS, Vasanthakumar D, Ambasankar K, Muralidhar M. 2017a. Effect of fermentation methods on amino acids, fiber fraction and anti-nutritional factors in dofferent plant protein sources and essential amino acids index for *Penaeus vannmaei* Boone, 1931. Indian Journal Fish 64: 40–47.

Jannathulla R, Dayal JS, Vasanthakumar D, Ambasankar K, Muralidhar M. 2017b. Effect of fungal fermentation on the nutrient digestibility of giar meal in *Penaeus vannamei*. Indian Journal Fish 64: 67–74.

Jannathulla R, Dayal JS, Vasanthakumar D, Ambasankar K, Muralidhar M. 2018a. Effect of fungal fermentation on apparent digestibility coefficient for dry matter, crude protein and amino acids of various plant protein sources in *Penaeus vannamei*. Aquaculture Nutrition 24: 1318–1329.

Jannathulla R, Dayal JS, Vasanthakumar D, Ambasankar K, Muralidhar M. 2018b. Effect of *Aspergillus niger* fermented soybean meal and sunflower oil cake on growth, carcass composition, and hemolimph indices in *Penaeus vannamei* Boone, 1931. Aquaculture 486: 1–8.

Jannathulla R, Dayal JS, Ambasankar K, Yuvapushpa R, Kumar JA, Muralidhar M. 2019. Evaluation on fungal fermented rapeseed meal as a fishmeal substitute in the diet of *Penaeus vannamei*. Journal of Coastal Research 86: 82-89.

Jobgen WS, Fried SK, Fu WJ, Meininger CJ, Wu G. 2006. Regulatory role for the arginine-nitric oxide pathway in metabolism of energy substrates. Journal of Nutritional Biochemistry 17: 571–588.

Kang SW, Park YS, Lee JS, Hong SI, Kim SW. 2004. Production of cellulases and hemicellulases by *Aspergillus niger* KK2 from lignocellulosic biomass. Bioesource Technomogy 91: 153–156.

Koedprang W, Charoendat U. 2019. Effect of *Aspergillus niger* fermented soybean meal supplementation in formulated diets on growth performances in juvenile Asian seabass (*Lates culcarifer* Bloch). Walailak Journal 17: 916–923.

Li MH, Robinson EH, Bosworth BG, Oberle DF, Lucas PM. 2011. Use of corn gluten feed and cottonseed meal to replace soybean meal and corn in diets for pond raised Channel catfish. North American Journal of Aquaculture 73: 153–158.

Li MH, Bosworth BG, Lucas PM. 2017. Replacing soybean meal with alternative protein sources in diets pond-raised hybrid catfish, ♀ *Ictalurus punctatus* × ♂ *Ictalurus furcatus*. Journal of the World Aquaculture Society 49: 755–760.

Melati I & Sunarno MTD. 2016. The effects of *Bacillus subtilis* cellulase enzyme on the decreasing of crude fiber of cassava peels for fish food ingredients. Widyariset 2: 57–66.

Mulyasari, Subaryono, Samsudin R, Widyastuti YR. 2018. Enhancement of nutrient quality of cassava starch residue as fish feedstuff through fermentation using *Bacillus megaterium* SS4b. Jurnal Riset Akuakultur 13: 147–157.

Muin H, Fatah NNA, Nor MHM, Razak SA. 2013. Rice bran replacement in *Clarias gariepinus* fingerlings diets with *Pleurotus florida* Stalk. Sains Malaysiana 42: 1109–1114.

Nates SF. 2016. Aquafeed Formulation. Oxford: Academic Press. 303p.

[NRC] National Research Council. 2011. Nutrient requirement of fish and shrimp. National Academy Press, Washington DC, USA. 376 pp.

Ngaddi A, Jusadi D, Wasjan, Supriyono E. 2019. Evaluation of monosodium glutamate supplementation on physiological response, growth performance, and feed utilization in North African catfish *Clarias gariepinus* (Burchell, 1822). Jurnal Ikhtiologi Indonesia 19: 337–348.

Novriadi R, Rhodes M, Powell M, Hanson T, Davis DA. 2018. Effects of soybean meal replacement with fermented soybean meal on growth, serum biochemistry and morphological condition of liver and distal intestine of Florida pompano Irachinotus carolinus. Aquaculture Nutrition 24: 1066–1075.

Pangestika W & Putra S. 2018. Fish feed formulation with the addition of sludge of dairy wastewater and fermented wheat bran. Jurnal Ilmiah Perikanan dan Kelautan 12: 21–30.

Putra AN, Ningsih CW, Nurani FS, Mustahal, Indaryanto FR. 2018. Evaluation of fermentation on Moringa leaves (*Moringa oleifera*) as raw material on tilapia (*Oreochromis niloticus*) feed. Jurnal Perikanan dan Kelautan 8: 104–113.

Putra AN, Maula IM, Aryati, Syamsunarno MB, Mustahal. 2020. Evaluation of moringa leaves (*Moringa oleifera*) meal hydrolyzed by sheep rumen liquor as feed ingredient for catfish feed (*Clarias* sp.). Jurnal Perikanan UGM 22:133–140.

Putra AN, Mustahal, Syamsunarno MB, Hermawan D, Fatimah DG, Putri PB, Sevia, Isnaini R, Herjayanto M. 2021. Dietary *Bacillus* NP5 supplement impacts on growth, nutrietnt digestibility, immune response, and resistance to *Aeromonas hydrophila* infection of African catfish (*Clarias gariepinus*). Biodiversitas 22: 253–261.

Phulia V, Sardar P, Sahu NP, Shamna N, Fawole FJ, Gupta S, Gadhave PD. 2017 Replacement of soybean meal with fermented *Jatropha curcas* kernel meal in the diet of *Labeo rohita* fingerlings: effect on hemato-biochemical and histopathological parameters. Journal of The World Aquaculture Society 48: 676–683.

Rostika R, Andriani Y, Abram AH, Vinasyiam A. 2017. The growth rate of Nile tilapia *Oreochromis niloticus* fry fed on fermented *Lemna* sp. Meal. Jurnal Akuakultur Indonesia 16: 101–106.

Samuel DE & Shapawi R. 2016. Effect of different inclusion levels of rice bran in the diet on the performance of African catfish (*Clarias gariepinus*) juveniles. Malaysia Applied Biology 45: 17–22.

Sansuwan K, Thongprajukaew K, Kovitvadhi S, Somsueb P, Kovitvadhi U. 2014. Improvement of carbohydrate quality in rice bran using microwave irradiation for Nile Tilapia feed production. Asian Fisheries Science 27: 104–116.

Shanma N, Sardar P, Sahu NP, Pal AK, Jain KK, Phulia V. 2015. Nutritional evaluation of fermented Jatropha protein concentrates in *Labeo rohita* fingerlings. Aquaculture Nutrition 21: 33–42.

Shi C, He Z, Yu J, Yu B, Huang Z, Mao X, Zheng P and Chen P. 2015. Solid state fermentation of rapessed cake with *Aspergillus niger* for degrading glucosinolates and upgrading nutritional value. Journal Animal Science Biotechnology 6: 13–19.

Su J, Hou H, Wang C, Luo Y. 2019. Effects of replacing soybean meal with cottonseed meal on growth, muscle amino acids and hematology of juvenile common carp, *Cyprinus carpio*. Aquaculture International 27: 555–566.

Surianti, Hasrianti, Wahyudi, Irwan M. 2021. Effect of fermented rice bran flour in artificial feed on survival rate and feed conversion ratio of tilapia, *Oreochromis niloticus* (Linnaeus, 1758). Jurnal Iktiologi Indonesia 21: 267–276.

Van Soest PJ. 1963. Use of detergent in the analysis of fibrous feeds. II. A rapid method for determination of fiber lignin. Journal of the Association of Official Agricultural Chemists 46: 829–835.

Yanto H, Junianto, Rostika R, Andriani Y, Tanuwiria UH. 2018. Effect of different levels of fermented rice bran for the growth of jelawat, *Leptobarbus hoevenii.* Nusantara Bioscience 10: 81–86.

Wu W, Ji H, Yu H, Sun J, Zhou J. 2020. Effect of refeeding dietary containing different protein and livid levels on growth performance, body composition, digestive enzye activities and metabolic related gene expression of grass carp (*Ctenopharyngodon idellus*) after overwinter starvation. Aquaculture 523: 735196.

Wang J, Zhang H, Yang Q, Tan B, Dong X, Chi S, Liu H, Zhang S. 2020. Effect of replacing soybean meal with cottonseed meal on growth, feed utilization and non-specific immune enzyme activities for juvenile white shrimp, *Litopenaeus vannamei*. Aquaculture Reports 16: 100255.

Zehra S, Khan MA. 2014. Dietary phenylalanine requirement and tyrosine replacement value for phenylalanine for fingerling *Catla catla* (Hamilton). Aquaculture 433: 256–265.