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Evaluation of the growth performace of nile tilapia (*Oreochromis niloticus*) fed with fermented rice bran

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Abstract

Feed contributes the highest expenditure in semi-intensive and intensive fish culture operations. Hence, there is a demand for alternative or substitute feeds that are readily available, cheap and can provide the nutrients needed by fish. This study was conducted to evaluate the effect of fermented rice bran on the growth performance of Nile tilapia (*Oreochromis niloticus*) reared and cultured in concrete tanks for 90 days. There were two treatments in the study. In treatment 1 (T1), fish were fed with commercial feeds while in treatment 2 (T2), fish were fed with fermented rice bran. Growth parameters such as gain in weight, specific growth rate (SGR), absolute growth rate (AGR) and feed conversion ratio (FCR) were observed. Survival rate and water quality parameters were also assessed. Results showed that T1 had better growth performance. T1 had significantly higher *($P > 0.05$)* values of gain in weight (23.38±1.55), SGR (4.85±0.15) and AGR (12.85±0.85) compared to T2. Moreover, mean FCR of T1 (1.11±0.06) was significantly better compared to T2 (1.42±0.11). This indicates that feeding fish with commercial feeds is still better than feeding with fermented rice bran alone. However, no significant difference *($P > 0.05$)* was observed on the survival rate and water quality parameters such as temperature, pH, dissolved oxygen and total ammonia nitrogen among the treatments. It denotes that water quality in both treatments was not affected by the diets given to fish since parameters were also within the acceptable range for tilapia culture.

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Introduction

Global aquaculture has grown dramatically over the past 50 years to around 52.5 million tons in 2008 accounting for around 50 percent of the world's fish food supply (Bostock *et al.,* 2010). One of the fish species which dominate the freshwater fish production is the tilapia (FAO, 2017). This fish species is a native of Africa and Middle East which has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world (Gupta and Acosta, 2004). Due to its high protein content, fast growth rate, large size and palatability, it has been well-known species in aquaculture.

Most tilapia farmers are involved in intensive and semi intensive culture systems which are typically conducted in tanks, ponds, and in open-water cages (Troell *et al.,* 2004). Nutrition is the most expensive component in the intensive aquaculture industry which represents over 50% of operating costs (El-Sayed, 2004). The intensification of tilapia culture requires the development of suitable feeds both for complete and supplementary feeding in tanks and ponds (Koprucu and Ozdemir, 2005). Therefore, the selection of proper quantity and quality of diet is a necessary way for successful tilapia culture practices. The major challenge for tilapia aquaculturists is the development of commercial, cost effective tilapia feeds using locally available, cheap and unconventional resources.

In rice growing countries, rice bran is a major by-product of rice (*Oryza sativa* L.) available for animal feeding (Mujahid *et al.,* 2003). According to Kahion (2009), annually, 63 to 76 million tons of rice bran are produced all throughout the world and more than 90% is sold cheaply as an animal feed. It is commonly used as ingredient in poultry and swine feeds. The limitation of its use was due to its high fiber content, low protein and antinutritional factors such as phytic acid. Thus, rice bran quality as feed can be improved by means of fermentation. It decreases the fiber, lipid, ash and phytic acid in the fermentation materials (Flores-Miranda *et al.,* 2014). In this study, fermented rice bran was used as a substitute to tilapia commercial feeds. The effect on growth of the fish and water quality parameters were assessed.

Materials and methods

Experimental units and treatments

Six circular concrete tanks with a diameter of 49.5 cm were used as culture units in the experiment. Fifty pieces of Nile tilapia fry was stocked and reared for three months in each tank. Fish was obtained from Freshwater Aquaculture Center, Central Luzon State University, Science City of Muñoz, and Nueva Ecija, Philippines.

There are two treatments in the study which were replicated thrice. In treatment 1 (T1), fish are fed with commercial feeds while on treatment 2 (T2), fish are fed with fermented rice bran (Table 1). The experimental setup used was Completely Randomized Design (CRD).

Preparation of fermented rice bran

Fermented rice bran was made by mixing 300 ml of water, 150g of rice bran and 5g of yeast. The rice bran was obtained from a local farm. The mixture was put in sterilized containers and stored in a dark and warm place for 15 hours to allow fermentation and obtain the fermented rice bran batter. Then, the fermented rice bran batter was dried under the sunlight for 8 hours and ground to produce the fermented rice bran flour which was fed to the Nile tilapia fry.

Feeding method and regime

Fish in all treatments were fed twice daily at 9:00 am and 3:00 pm. Feeding of the fish started a week after stocking. Feeding rate of the experimental fish is based on guidelines made by Freshwater Aquaculture Center, Central Luzon State University as shown in Table 2.

Sampling

Sampling of weight of the stocked Nile tilapia was done every 15 days to obtain the weight of fish for the adjustment of their feeding requirements. Ten percent of the total population per concrete tank was used as samples.

Water quality parameters

Water quality parameters such as temperature (˚C), dissolved oxygen (mg/L) and pH was recorded daily during the entire duration of the study. The dissolved oxygen and temperature were measured by a DO meter device with temperature reading while the pH was measured using the pH meter instrument. These water quality parameters were measured at 8:00-9:00 in the morning and 2:00-3:00 in the afternoon.

Total ammonia-nitrogen (mg/L) was recorded every 15 days throughout the duration of the study. Water samples were collected at 7:00-8:00 in the morning and analyzed in the laboratory.

Growth parameters

Growth of the fish was assessed by computing and determining the following parameters: gain in weight, feed conversion ratio (FCR), specific growth rate (SGR) and absolute growth rate (AGR). Survival rate was also observed in all the treatments.

Statistical analysis

The data were subjected to T-test for Complete Randomized Design (CRD) using statistical program for social studies (SPSS) version 16.0.

Results and discussion

Growth performance

The analysis of variance revealed that gain in weight of Nile tilapia in T1 is significantly higher compared to T2 (Table 3). Results indicate that fish fed with commercial feeds has greatly increased its weight after three months of culture period in concrete tanks compared to fish fed with fermented rice bran. In the study of Ngugi *et al.* (2016), growth performance of Nile tilapia fed with fishmeal, combination of rice bran and atyid shrimp, and rice bran alone was compared and evaluated. Results also showed that feeding of rice bran alone obtained the lowest fish growth performance among the three treatments.

Table 1. Experimental treatments in the study.

Treatments	Feed ration
1 (T1)	Commercial feeds (Control)
2 (T2)	Fermented rice bran

Rice bran contains nutrients such as proteins (13.80%), fat (16.40%) including 80 to 85% of unsaturated fatty acids, fibres (7.80%), vitamins and minerals (Sauvant and Tran, 2004). However, there are some antinutritional factors, such as trypsin inhibitors phytates and antithiamine factor (Deniz *et al.,* 2007) that may inhibit the growth of animals. One of the ways how to improve rice bran quality in the diet can be done through fermentation technology. It breaks down complex compounds into simpler ones that may increase the coefficients of digestibility and fish growth (Suprayudi *et al.,* 2012; Mulyasari *et al.,* 2013). However, according to Yanto *et al.* (2018), there should be an optimum level of fermented rice bran in the diet in order to produce high daily growth rate and feed efficiency.

Table 2. Feeding regime used in the study.

Fish age	% Feeding rate (average body weight of fish)
Day 1-30	30
Day 31-60	15
Day 61-90	8

This was proven in the fish species jelawat (*Leptobarbus hoevenii)* which attained the highest daily growth rate and feed efficiency by feeding a diet containing 30% of fermented rice bran.

On the same way, SGR and AGR of fish in T1 were also significantly higher compared in the fish in T2 (Table 3). In the study of Veverica *et al.* (2001), Nile tilapia fed solely with rice bran grew much slower compared to the fish fed with pig finisher pellets (PFP), and test diet pellets (TDP). Furthermore, fish fed with rice bran attained a significantly lower net fish yield and annual production. Commercial feeds are usually complete feeds which contains the necessary and exact amount of nutrients (protein, carbohydrates, fats, vitamins, and minerals) needed by fish for optimal growth (Craig, 2017). The amount of nutrients incorporated in feeds depends on what species of fish is being cultured and at what life stage.

Compared to fermented rice bran, commercial feeds offers a diet with right amount of the specific nutrients needed by fish to grow.

Table 3. Summary of the results on growth performance of Nile tilapia *(Oreochromis niloticus L.)* after the 90 days of culture period.

Growth parameters	T1	T2
Initial bulk weight (g)	14.000±1.7321^{a}	13.000±0.0000^{a}
Final bulk weight (g)	1183.333±2.75^{a}	591.667±3.45^{b}
Gain in weight (g)	23.38±1.55^{a}	11.58±0.77^{b}
Specific growth rate (%)	4.85±0.15^{a}	4.22±0.10^{b}
Absolute growth rate (g/day)	12.85±0.85^{a}	6.36±0.42^{b}
Survival rate (%)	95.33±4.62^{a}	88.00±3.46^{a}

Note: Means in a column superscripted with different letters are significantly different at 5% probability.

In terms of survival rate, there was no significant difference between the treatments. High survival rates were recorded on both treatments which means that the diets (commercial feeds and fermented rice bran) given to the fish in the study did not affect the survival rate. This can be attributed to the optimum range of water quality parameters observed in the study. It has been established that fish survival rate, condition factor and growth performance of cultured fish partly depends on water quality (Shoko *et al.,* 2014). The results are also the same in the study of Ngugi *et al.* (2016) and Veverica *et al.* (2001) wherein treatments which included the fish fed with rice bran has no significant difference compared with other treatments in terms of survival rate.

Table 4. Mean Feed Conversion ratio of Nile tilapia *(Oreochromis niloticus L.)* after 90 day culture period.

Treatments	Mean Feed Conversion Ratio
1	1.11±0.06^{a}
2	1.42±0.11^{b}

Note: Means in a column superscripted with different letters are significantly different at 5% probability.

Feed conversion ratio (FCR)

Nile tilapia in T1 attained a better FCR with a mean value of 1.11 as compared with T2 with a mean value of 1.42 (Table 4). Analysis of variance revealed significant difference among the treatments ($P<0.05$). In the study of Ngugi *et al.* (2016), the FCR of the fish in the treatment fed with fish meal was better than in the treatment fed with rice bran. FCR is a good tool to measure the acceptability and suitability of feed for fish. It determines whether the feed is being used as efficiently as possible. For Trout, salmon, and tilapia, best FCR values usually range from 0.9 to 1.3 (Craig, 2017).

Water quality parameters

Good water quality parameters should be maintained to increase the survival rate and promote optimum growth to the cultured fish. The water quality parameters observed in the study were temperature, pH, DO and Total Ammonia Nitrogen. Mean values for each parameter are showed in Table 4. There were no significant differences in all the water quality parameters assessed. This shows that the water quality in both T1 and T2 were not affected by the diets given to the fish. The results also conform to the study of Limbu *et al.* (2016), wherein no difference was observed in fish fed with rice bran alone and fish fed mixed feed ingredients.

Table 5. Mean of the water quality parameters observed in the study.

Treatment	Mean (±SD)			
	Temperature (°C)	pH	Dissolved Oxygen (mg/L)	Total Ammonia Nitrogen
I	27.48±11.65[a]	7.91±0.34[a]	5.01±3.54[a]	0.99±0.25[a]
II	26.64±3.03[a]	7.88±0.34[a]	5.41±3.51[a]	0.99±0.23[a]

Moreover, all the mean of the water quality parameters observed are within the acceptable range for tilapia culture. According to Ngugi *et al.* (2007), the temperature for best tilapia growth is between 20°C to 35 °C. Nile tilapia is a warm water species and its lower and upper lethal temperatures are 11-12 °C and 42 °C (FAO, 2005). For pH, the suitable range for tilapia culture ranges from 6.7 to 9.5 (Santhosh and Singh, 2007). However, according to Ekubo and Abowei (2011), fish can be stressed if the pH of the water is ranging from 4.0 to 6.5 and 9.0 to 11.0. Death is almost certain at a pH of less than 4.0 or greater than 11.0.

Maintaining adequate levels of dissolved oxygen is necessary to satisfy the functions responsible for improving fish performance and health (Abdel-Tawwab *et al.,* 2015). The preferred DO for optimum growth of tilapia is above 5 mg/L (Riche and Garling, 2003). DO levels of 1-3mg/l has sub lethal effects on the growth and feed utilization of the fish while DO levels of DO levels of 0.3–0.8 mg/l will cause fish mortality (Bhatnagar *et al.,* 2004). For the Total Ammonia Nitrogen, the acceptable value is <4 mg/L, while desirable range is within 0 – 2 mg/L (Stone and Thomforde, 2004). Ammonia is the major nitrogenous waste product of fish and a product of decomposing of organic matter. It is toxic to fish at higher levels and can adversely affect its health.

Conclusion

Based on the results of the study, fish fed with commercial feeds had better growth performance than fish fed with fermented rice bran alone. Significantly higher values of gain in weight, SGR and AGR were obtained by the fish fed with commercial feeds. The value of its FCR was also significantly better. Higher survival rate was also seen in the control group. However, no significant difference on the survival rate and water quality parameters was observed among the treatments. Mean values of temperature, pH, dissolve oxygen and Total Ammonia Nitrogen in both treatments were also within the optimum levels for tilapia culture.

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