Effect of addition of fermented restaurant waste meal in artificial feed on the growth of nile tilapia (*Oreochromis niloticus*)

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Abstract. This research aims to determine the optimal probiotic concentration and to analyze the effect of addition of fermented restaurant waste meal (FRWM) in feed to growth of nile tilapia. The research was carried out from February-June 2019 at Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran. This research used experimental method with a Completely Randomized Design (CRD) consisting of five treatments and three replications. The treatments given consisted of addition of 0, 10, 20, 30 and 40% of FRWM in feed. The parameters observed included changes in the nutritional value of restaurant waste, daily growth rate, survival, feed conversion ratio, and water quality. Data were analyzed using analysis of variance. and was further analyzed using Duncan's multiple range test 5%. The results showed that the addition of 8% probiotic concentration was able to provide the best change in the nutritional quality of restaurant waste by increasing feed protein by 50.83% and decreasing crude fiber by 30.74%. The use of 30% fermented restaurant waste meal in feed gave the highest daily growth rate of 1.57% and the best feed conversion ratio of 0.57 with a survival rate ranging from 75-90%.

1. Background

Nile tilapia (*Oreochromis niloticus*) is a freshwater fish species that has high economic value and is widely cultivated to fulfill consumer demand for animal protein. Indonesia ranks second as the largest producer in nile tilapia aquaculture production with a total production of 1.12 million metric tons (MMT) [1].

Fish farming activities will spend relatively large production costs for feed. Provision of feed is one of the determining factors for the success of fish farming activities. The high cost of feed that must be incurred is because the feedstuff become more expensive such as fish meal and soybean meal [2]. Restaurant waste is one of the organic wastes that can be used as an alternative feed ingredient [3, 4]. Restaurant waste contains 26.55% protein, 11.10% crude fiber, 1.16% fat, 0.11% calcium and 0.17% phosphorus [5]. This restaurant waste was the mix of vegetables, food scraps, bones, meat, fish, eggs or other food scraps. Giving waste directly as fish feed will not provide optimal growth because of its low nutritional content, so it is necessary to make waste treatment efforts to increase the nutrient content of the waste [6].

Improving the nutritional quality of restaurant waste can be done by utilizing microbes, biologically known as fermentation [7]. Fermentation can be done by adding probiotics [6]. According to Aslamyah
et al. 2017 [8] the fermentation process can reduce the high crude fiber and increase the nutritional value of an ingredient.

Based on the explanation above, it is necessary to conduct further research on the effect of adding fermented restaurant waste in artificial feed to the growth of Nile tilapia. This research aims to determine the optimal probiotic concentration for the fermentation of restaurant waste and to analyze the optimal amount of addition of fermented restaurant waste meal in artificial feed for the growth of Nile tilapia.

2. Research Methodology

2.1. Time and Place
The research was carried out in February-June 2020 at the Ciparanje Hatchery, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran and proximate feed analysis was carried out at the Laboratory of Ruminant Nutrition and Feed Chemistry, Faculty of Animal Husbandry, Universitas Padjadjaran.

2.2. Materials
The materials used in this research were fresh restaurant waste from Sundanese food restaurants, liquid BIOM-S Probiotic produced by the Biomethagreen, molasses, feed ingredients consisting of fish meal, soybean meal, bran, Topmix fish oil, tapioca as a binder, Nile tilapia fries (size of 5-8 cm and with weight around 4.5 ± 0.5 grams from the Fish Seed Center (BBI), in Cibiru, West Java.

2.3. Research Method
The research method used in this research is an experimental method using a Completely Randomized Design (CRD) consisting of five treatments and three replications for each treatment, which are as follows:
A = feed contains 0% fermented restaurant waste
B = feed contains 10% fermented restaurant waste
C = feed contains 20% fermented restaurant waste
D = feed contains 30% fermented restaurant waste
E = feed contains 40% fermented restaurant waste

2.4. Procedure

2.4.1. Preparation Stage
500 grams restaurant waste was collected, dried and its nutritional value was analyzed using proximate analysis. A total of 5 kg of restaurant waste was chopped, then fermented using probiotics with concentrations of 0, 6, 8, and 10% of the total weight of the test sample and molasses was added with 10% of the concentration of the probiotics. The sample was incubated for 7 days, followed by proximate analysis. The best proximate analysis results were selected based on the indicators of the highest increase in protein and the largest decrease in crude fiber, and were applied in the mass fermentation process.

2.4.2. Research Implementation
The test fish were cultures in aquarium with a density of 1 fish / 2 liter [8]. Fish cultivation was carried out for 42 days. Feeding 5% of the body weight of the fish were carried out 3 times a day in the morning at 07.00 WIB, noon at 12.00 WIB and evening at 17.00 WIB. Cleaning the aquarium by syphoning were carried out every 2-3 days in the afternoon before feeding, by sucking out as much as 20% of the water at the bottom of the aquarium. Observation of the weight of fish fries was carried out by weighing all fish fries in the aquarium (20 fishes). If there were dead fish, the fish was weighed and the fish was not replaced. Furthermore, water quality parameters were also measured in the form of temperature, pH, and DO; and the testing were carried out every 7 days, while ammonia level was only measured at the beginning, middle, and end of the research.
Table 1. Test Feed Formulation.

| Materials                | Concentration of addition of FRWM |
|--------------------------|-----------------------------------|
|                          | 0%      | 10%     | 20%     | 30%     | 40%     |
| Fish meal (%)            | 22.62   | 23.86   | 25.25   | 29.13   | 28.56   |
| Soybean meal (%)         | 22.62   | 19.09   | 15.15   | 11.65   | 5.71    |
| FRWM (%)                 | 0       | 4.77    | 10.10   | 17.48   | 22.85   |
| Bran meal (%)            | 46.76   | 44.27   | 41.51   | 38.40   | 34.88   |
| CMC (%)                  | 5       | 5       | 5       | 5       | 5       |
| Fish oil (%)             | 2       | 2       | 2       | 2       | 2       |
| Premix (%)               | 1       | 1       | 1       | 1       | 1       |
| Total (%)                | 100     | 100     | 100     | 100     | 100     |

Description: Fermented Restaurant Waste Meal (FRWM)

2.5. Research Parameters

The parameters observed in this research are: 1) Change of nutritional value of restaurant waste, the parameters observed were changes in the nutritional value of restaurant waste with proximate analysis carried out before and after fermentation, analysed according to AOAC (1990) [9] standard methods, 2) Daily Growth Rate [10], 3) Feed Conversion Rate [11], 4) Survival rate [10].

2.6. Data Analysis

The nutritional content of restaurant waste was analyzed using proximate analysis. The data from the observations were analyzed using the Analysis of Variance (ANOVA) One-way F test with a 95% confidence level, if a significant difference is detected, Duncan's multiple range test is performed [12]. Water quality data were analyzed descriptively and comparatively.

3. Result and Discussion

3.1. Change of nutritional value of restaurant waste

Fermentation aims to improve the quality of feed ingredients so that they have an effect on better fish growth by increasing the feed digestibility. Changes in nutritional value can be seen in the test results of feed ingredients before and after fermentation (Table 2).

Table 2. Nutritional content of fermented restaurant waste

| Parameter     | Waste before fermentation (%) | Waste after fermentation (%) | Nutritional Change (%) |
|---------------|-------------------------------|------------------------------|------------------------|
| Protein       | 15.58                         | 23.50                        | 50.83                  |
| Crude Fiber   | 4.88                          | 3.38                         | 30.74                  |
| Fat           | 7.77                          | 7.17                         | 7.72                   |
| Water Content | 12.67                         | 7.68                         | 39.38                  |
| Ash Content   | 6.54                          | 9.37                         | 43.27                  |
| BETN          | 64.96                         | 56.58                        | 12.90                  |

Source: Laboratory Analysis of Ruminant Nutrition and Feed Chemistry, Faculty of Animal Husbandry, Universitas Padjadjaran (2019)

Based on Table 2, it can be seen that most of the nutritional value in restaurant waste after fermentation changes, especially from the increased protein value and decreased crude fiber value. The protein value of restaurant waste before fermentation was 15.58%, and increased after fermentation to 23.50%, which indicates that the increase in protein value was 50.83%. The increase in protein content is due to the addition of BIOM-S probiotic which consists of three types of microorganisms (two bacteria and one yeast) during the fermentation process. One of the microorganisms that play a role in increasing the protein content is the bacterium Bacillus sp. These bacteria are classified as Saccharolytic bacteria,
which are bacteria capable of breaking down disaccharides or polysaccharides into simpler molecular groups [13]. Furthermore Aslamyah et al. [8], stated that Bacillus sp. has the ability to break down protein into amino acids and multiply. The activity of the bacteria Bacillus sp. able to increase the protein content in feed ingredients by multiplying themselves and when the bacteria die it will donate nitrogen which of course causes the protein to increase because most of the body cells are composed of protein.

Crude fiber in feed ingredients has decreased by 30.74% from 4.88% to 3.38%. This is closely related to the role of Lactobacillus sp., which was able to reduce crude fiber content because these bacteria produce cellulase enzymes, this enzyme which ultimately breaks down cellulose into glucose and makes it easier for fish to digest it [14]. Apart from these two types of microbes, it is evident that the role of Saccharomyces cerevisiae has an effect in simplifying the compounds in fermented feed ingredients during the biochemical process because it acts as a biocatalyst [15].

The fermentation of restaurant waste in this research shows better results from fermentation Lemna sp. with of EM4 [16]. The results showed that the Lemna sp. which originally had a protein nutritional content of 24%, 15.19% crude fiber, and 7.81% fat after undergoing fermentation, there was a change in nutritional content, such as protein to 25.35%, crude fiber 12.87% and crude lipid 8.26%.

3.2. Daily Growth Rate
In general, growth is used as a parameter to evaluating the effect of feed on fish. Based on the results of observations on Nile tilapia fries treated with fermented restaurant waste meal in feed cultivated for 42 days with five different treatments, showed the results of different growth. The addition of fermented restaurant waste to fish feed showed a different daily growth rate for each treatment (Table 3).

The results of the Duncan test showed that the addition of FRWM fish showed a significant difference between those given FRWM and the control ones. This shows that the addition of 30% FRWM has a good effect on fish growth. The fermentation process is able to convert long chain proteins into short chain peptide bonds, so fish will easily digest and absorb when simpler compounds are produced, such as amino acids. Fermentation process will remodel the complex compounds in the feed into simpler compounds so that they are easily absorbed through the intestinal wall and spread throughout the body through the circulatory system [17].

The results of this study indicate that the amount of use of fermented waste that produces the best growth is 30%, higher than the addition of lupine (Lupinus albus), the best fermentation results in common carp (Cyprinus carpio) by 25% [6], but lower compared with the provision of fermented GOC incorporated up to 40% level (w / w) in the diet for rohu (Labeo rohita) fingerlings [12]. This shows that the quality of waste nutrients used will affect the optimal amount of use in feed.

The daily growth rate of red Nile tilapia fed with the addition of fermented Lemna sp using EM4 probiotics showed a daily growth rate ranging from 0.81–1.20%/day with the addition of fermented Lemna sp of 20% which produced the highest growth rate value [16].

Table 3. Nile tilapia fries daily growth rate.

| Treatment       | Daily Growth Rate (%) | Average Feed Conversion Ratio | Survival Rate (%) |
|-----------------|-----------------------|-------------------------------|-------------------|
| A (Control)     | 0.97±0.08<sup>a</sup> | 0.74±0.04<sup>c</sup>         | 75.00±8.70<sup>a</sup> |
| B (addition of 10% FRWM) | 1.29±0.05<sup>b</sup> | 0.65±0.03<sup>b</sup>         | 81.67±27.5<sup>a</sup> |
| C (addition of 20% FRWM) | 1.38±0.18<sup>b</sup> | 0.64±0.06<sup>b</sup>         | 86.67±7.60<sup>a</sup> |
| D (addition of 30% FRWM) | 1.57±0.04<sup>c</sup> | 0.53±0.01<sup>a</sup>         | 90.00±8.70<sup>a</sup> |
| E (addition of 40% FRWM) | 1.42±0.04<sup>bc</sup> | 0.60±0.04<sup>bc</sup>        | 88.33±7.60<sup>a</sup> |

Description: FRWM (Fermented Restaurant Waste Meal); The value followed by the same lowercase letter is not significantly different based on Duncan's multiple range test at the 95% confidence.

3.3. Feed Conversion Rate
The feed conversion ratio has a relationship with the quality of the feed given and shows the effectiveness of the use of feed to be converted into meat. The results showed that the feed conversion ratio was in the range of 0.53-0.74 as shown in Table 3.
Table 4 shows that the feed conversion ratio is in line with the daily growth rate for each treatment. The feed conversion ratio that gave significant was treatment D (FRWM 30%). It is clear that the feed added to the fermented restaurant waste meal gave a relatively low feed conversion ratio and the difference between treatments added by FRWM was not very significant. However, when compared with the control treatment, the difference is very significant, as shown by the highest feed conversion ratio. This shows that the feed which is added to the feed constituents through the fermentation process has advantages in terms of ease of digestion and better absorption by fish when compared to feed whose constituents have no fermented ingredients.

The ability of fermentation to break down complex molecules into simple ones has an effect on the density between particles of the material. Based on the research of Andriani et al. [18], showing that Lemna sp. which through the fermentation have a better quality can be seen from the physical properties test, where the distance between the particles becomes smaller. A decrease in particle size will change the characteristics of the material to a higher level of solubility, this will make it easier for the material to react with digestive enzymes and make it easier for the ingredients to combine with other feed ingredients.

The feed conversion ratio in this study produces a better value than the following studies. Research by Dawood et al. [19] stated that the feed conversion value of Oreochromis niloticus which is given the fermented poultry by-product meal (FPBM) ranges from 1.22-1.37.

3.4. Survival rate
The survival rate of nile tilapia ranges between 75-90%, it can be seen that each treatment gave no significant difference (Table 3). Feed that is given additional fermented products has a survival value above 80%. Probiotic bacteria are really supportive for the health of organisms [13]. Fermentation helps decomposition as biological process that makes the most of bacteria's ability to produce growth substances, hormones, vitamins, and other enzymes [20, 21]. This also proves that the addition of fermented restaurant waste meal in the feed has no effect on the survival of nile tilapia.

The survival rate of fish fed fermentation-based feed generally provides a better survival value than non-fermented feed. The survival rate of Clarias gariepinus has an almost average value ranging from 88.89-89.23% by adding fermented Jatropha curcas Kernel in feed [22]. The survival rate related water quality during fish cultivation, which was suitable for the growth of nile tilapia fries, and still in the range of values recommended for nile tilapia cultivation.

4. Conclusion
Addition of 8% probiotics improved the nutritional quality of restaurant waste the best; by increasing protein by 50.83% and decreasing crude fiber by 30.74%. The addition of 30% fermented restaurant meal in the artificial feed formulation gave the best growth rate, feed conversion ratio, and survival rate with successive values of 1.57%; 0.53; and 90% respectively.

Acknowledgement
Authors would like to thanks Kemenristek-Dikti of Indonesia for financial support by Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT) 2020 No. 1827/UN6.3.1/LT/2020

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