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THE EFFECT OF FERMENTED DUCK BONE FLOUR DOSAGE USING MIXED MICROORGANISMS ON INCREASING FEED NUTRITION AND GROWTH OF NILE FISH (*Oreochromis niloticus)*

Pengaruh Dosis Tepung Tulang Itik Terfermentasi Menggunakan Mikroorganisme Mix Terhadap Peningkatan Nutrisi Pakan dan Pertumbuhan Ikan Nila (Oreochromis niloticus)

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ABSTRACT

The high cost of fish feed in Indonesia, particularly in Sidenreng Rappang Regency, remains one of the main challenges in aquaculture development. This study aimed to determine the effect of different doses of mixed microorganisms in fermented duck bone meal on feed consumption, growth performance of Nile tilapia (*Oreochromis niloticus*), and hepatosomatic index (HSI). The research used a Completely Randomized Design (CRD) consisting of five treatments and three replications, resulting in 15 experimental units. The culture system used floating net cages measuring 2 meters in length, 1 meter in width, and 0.5 meters in height, each divided into five compartments measuring 40 × 40 cm. The treatments were as follows: A = 10% fermented duck bone meal, B = 15%, C = 20%, D = 25%, and E = 30%. Sampling was carried out weekly to monitor the weight of the fish and adjust feed allocation. Data were analyzed using analysis of variance (ANOVA), and if significant differences were found, the W-Tukey post hoc test was applied to identify the best-performing treatment. Water quality parameters, including temperature and pH, were measured daily using a digital thermometer and a pH meter. The results showed that Treatment D yielded the best proximate composition of feed with a crude protein content of 38.72%. In terms of growth and feed consumption, Treatment D also recorded the highest values, with a growth rate of 4.796±0.10 g and feed consumption of 11.73±0.13 g. However, the highest hepatosomatic index (HSI) was observed in Treatment A, with a value of 3.11±0.32.

Key words: Comsumption, Feed, Fish, Growth, Hepatosomatic

ABSTRAK

Harga pakan ikan di Indonesia yang sangat mahal, khususnya di Kabupaten Sidenreng Rappang yang masih menjadi salah satu permasalahan utama didalam proses budidaya ikan. Penelitian ini bertujuan untuk mengetahui pengaruh perbedaan dosis mikroorganisme mix terhadap tingkat konsumsi pakan, pertumbuhan ikan nila, dan hepatosomatik index (HIS). Metode yang digunakan dalam penelitian ini adalah rancangan acak lengkap (RAL) dengan 5 perlakuan dan 3 ulangan, sehingga terdapat 15 wadah percobaan, wadah yang digunakan keramba jaring apung yang berukuran panjang 2 meter, lebar 1 meter, dan tinggi 50 cm sebanyak 3 buah. Adapun lebar masing-masing sekat jaring keramba adalah 40 cm persegi, sebanyak 15 sekat. Perlakuan A = 10 % tepung tulang itik terfermentasi, Perlakuan B = 15 % tepung tulang itik terfermentasi, Perlakuan C = 20 % tepung tulang itik terfermentasi, Perlakuan D = 25 % tepung tulang itik terfermentasi, Perlakuan E = 30 % tepung tulang itik terfermentasi. Sampling dilakukan setiap minggu, untuk mengetahui bobot hewan uji dan penyesuaian pemberian pakan. Data di analisis menggunakan analisis ragam (ANOVA) apabila berpengaruh nyata maka dilanjutkan dengan uji W-Tukey untuk melihat perlakuan mana yang memberikan hasil terbaik. Pengukuran kualitas air dilakukan setiap hari dengan menggunakan alat ukur termometer digital dan pH meter. Berdasarkan hasil penelitian menunjukkan perlakuan dengan nilai terbaik pada analisis proksimat pakan adalah perlakuan perlakuan D dengan nilai protein kasar 38,72%. Pada parameter pertumbuhan dan komsumsi pakan adalah perlakuan D dengan nilai pertumbuhan (4,796±0,10) dan nilai komsumsi pakan (11,73±0,13). Sedangkan di parameter Hepatosomatik Indeks perlakuan A (3,11±0,32).

Kata Kunci: Hepatosomatik, Ikan, Konsumsi, Pakan, Peterumbuhan

INTRODUCTION

Tilapia (*Oreochromis niloticus*) is the most widely farmed tilapia species in Indonesia, both on a large and small scale. In Asia, there are five major tilapia producing countries: China, Indonesia, Taiwan, Thailand, and Malaysia (FAO, 2016). Tilapia is marketed internationally in various forms, such as frozen whole, filleted, and breaded. Tilapia farming is expected to become a major business in the future, along with the increasing demand for healthy animal protein. As the second-largest tilapia producer in the world, Indonesia needs to prepare itself to face this opportunity (Fujaya *et al.,* 2021).

Sidenreng Rappang Regency has significant potential for developing tilapia farming, particularly due to the fish's high popularity in South Sulawesi, particularly in the Sidenreng Rappang region. Tilapia farming development in this area can significantly contribute to the local economy if properly managed. To achieve optimal production, efforts are needed to increase it through intensive farming supported by the provision of high-quality feed (Putra *et al*., 2011). However, one of the main challenges in intensive cultivation is the high cost of feed, which can reach 60-70% of the total production cost, especially at the fish rearing stage (Tacon & Metian, 2015). Thus, efforts to develop efficient feed sources, both in terms of cost and quality, will greatly help increase the productivity of tilapia cultivation in Sidenreng Rappang Regency.

Utilizing duck bone waste as a raw material for fish feed is a highly promising idea, especially in areas with numerous restaurants, such as Sidenreng Rappang, which serves the signature dish, Itik Palekko. With the right approach, this could be a viable solution for several reasons: reducing waste, reducing dependence on more expensive and difficult-to-find feed ingredients, and improving the quality of fish feed, which contains essential nutrients. Duck bones contain calcium, phosphorus, and protein, which are essential for supporting fish growth, especially for the widely cultivated tilapia. The process of converting duck bone waste into fish feed can be carried out through several stages, such as drying, grinding, and further processing to meet the fish's nutritional needs. With the right process, these duck bones can be an excellent source of calcium and phosphorus to improve fish immunity and growth. The use of duck bone meal not only helps reduce feed costs and reduces dependence on fish meal, whose price fluctuates, but also supports the principle of environmentally friendly waste management. This helps reduce waste from the poultry industry and supports sustainable fish farming (Nasution *et al.,* 2020). Furthermore, duck bone meal can also be used as a substitute for feed ingredients. Meat and bone meal contains approximately 45-55% protein (Qisti *et al.,* 2021).

However, the use of duck bone meal as a feed ingredient is still limited due to its low digestibility. To improve its quality, duck bone meal needs to undergo a fermentation process before being added to feed. This fermentation process aims to improve nutritional content, increase digestibility, and reduce or even eliminate anti-nutritional compounds that may be present in the feed ingredient. Fermentation can be carried out with the help of microorganisms that break down complex components into forms that are more easily digested by fish (Nista *et al*., 2007; Lestari *et al.,* 2019). Research shows that fermentation of feed ingredients can increase nutritional value and optimize their use in fish feed, thus supporting more efficient aquaculture (Putri *et al.,* 2021).

Fermentation is a biological process involving microorganisms to convert organic matter into more digestible forms. The use of mixed microorganisms, such as lactic acid bacteria, yeast, and protein-degrading bacteria, can improve the nutritional quality of duck bone meal by increasing protein digestibility, reducing anti-nutritional compounds, and increasing the availability of essential minerals. Research has shown that fermentation can break down the complex structure of proteins and minerals in bone meal, making them more easily absorbed by fish (Wang *et al.,* 2017). Thus, fermentation of duck bone meal using mixed microorganisms not only offers a solution to reduce feed costs but also supports more environmentally friendly and sustainable aquaculture practices. Based on this, research entitled the effect of fermented duck bone meal dosage using mixed microorganisms on increasing feed nutrition and tilapia growth needs to be done. The formulation of the problem is 3, namely How does the fermented duck bone meal dosage using mixed microorganisms affect the nutritional content of duck bone meal, How does the fermented duck bone meal dosage using mixed microorganisms affect the growth rate and feed consumption level of tilapia (*Oreochromis niloticus*), and Does the fermented duck bone meal dosage using mixed microorganisms have a significant effect on the hepatosomatic index (HSI) of tilapia (*Oreochromis niloticus*) With the objectives of analyzing the effect of fermented duck bone meal dosage using mixed microorganisms on increasing the nutritional content of duck bone meal, determining the effect of fermented duck bone meal dosage on the growth rate and feed consumption level of tilapia (*Oreochromis niloticus*) and evaluating the effect of fermented duck bone meal dosage on the hepatosomatic index (HSI) of tilapia (*Oreochromis niloticus*).

RESEARCH METHODS

This research was conducted in January-March 2025 in Tonrong Rijang Village, Baranti District, Sidenreng Rappang Regency, South Sulawesi Province. This research used various tools and materials tailored to the needs of cultivation and feed processing activities. The tools used include cage nets, spoons, measuring cups, aeration, seser, netting, digital scales, digital pH meters, cameras, and sprayers. Meanwhile, the materials used include duck bone meal, mixed microorganisms (*Bacillus* sp., *Rhizopus* sp., and *Saccharomyces* sp.), corn flour, wheat flour, soybean flour, rice bran, vitamins, minerals, granulated sugar, coconut water, and tilapia as test animals. Duck bone preparation and fermentation process were obtained from one of the palekko'itik food stalls in Sidenreng Rappang. The preparation of duck bone meal begins with washing and reducing the size of the bones, then boiling them using a pressure cooker for 1 hour. The softened bones were oven-dried at 60°C for 20 hours, then blended and sieved to form flour (Putranto *et al.,* 2016). The microorganism mixture, consisting of *Bacillus* sp., *Rhizopus* sp., and *Saccharomyces* sp., was refreshed first, then mixed and diluted (Aslamyah *et al.,* 2017). Fermentation was carried out by adding 1.5 ml of the microorganism mixture to 100 g of bone meal, spraying it evenly, and fermenting it for 36 hours in a closed container. After fermentation, the flour was steamed for 1 minute at 60°C to stop enzyme activity, then cooled. The fermented flour was then analyzed in the laboratory. The research preparations carried out included first preparing the research container, Test Animals, Preparation of Test Feed and the maintenance process.

The research method used was a completely randomized design (CRD) with 5 treatments and 3 replications, resulting in 15 experimental tanks, each containing 20 fish weighing 1.5 grams. The treatments were as follows:

Treatment A = 10% fermented duck bone meal; Treatment B = 15% fermented duck bone meal; Treatment C = 20% fermented duck bone meal; Treatment D = 25% fermented duck bone meal; and Treatment E = 30% fermented duck bone meal. Three parameters were used: growth rate, feed consumption level, and hyposomatic index. Data analysis used in this study was analysis of variance/Analysis of Variance (ANOVA). If the results were significant, a Tukey W-test was used to determine which treatment provided the best results. Water quality analysis was conducted descriptively based on the suitability of tilapia for survival.

RESULT

Specific Growth Rate

The absolute growth of tilapia after being fed fermented duck bone meal using mixed microorganisms with different treatments is shown in Table 1.

Table 1. Average specific growth rate of tilapia during the study

Treatment	Parameter ± Std
	Growth (%/day)
A	$3,411 \pm 0,07^{a}$
B	$3,529 \pm 0,09^{a}$
C	$4,142 \pm 0,12^{b}$
D	$4,796 \pm 0,10^{c}$
E	$4,330 \pm 0,07^{b}$

Note: Different superscript letters in the same column indicate significant differences between treatments at the 95% confidence level (P<0.05).

Feed Consumption

Feed consumption of fermented duck bone meal using mixed microorganisms with different treatments is shown in Table 2.

Table 2. Average feed consumption of tilapia during the study

Treatment	Parameter ± Std
	Feed consumption
A	10,36 ± 0,46^{ab}
B	10,00 ± 0,80^{a}
C	11,45 ± 0,22^{bc}
D	11,73 ± 0,13^{c}
E	10,99 ± 0,40^{abc}

Note: Different superscript letters in the same column indicate significant differences between treatments at the 95% confidence level (P<0.05).

Hepatosomatic Index

The average hepatosomatic index of fermented duck bone meal feed using mixed microorganisms with different treatments is shown in Table 3.

Table 3. Average hepatosomatic index of tilapia during the study

Treatment	Parameter ± Std
	Feed consumption
A	3,11 ± 0,32^{b}
B	2,49 ± 0,39^{ab}
C	2,04 ± 0,08^{a}
D	2,05 ± 0,08^{a}
E	1,92 ± 0,01^{a}

Note: Different superscript letters in the same column indicate significant differences between treatments at the 95% confidence level (P<0.05).

DISCUSSION

Specific Growth Rate

Based on the analysis of variance (ANOVA) results, feeding duck bone meal fermented using a mixture of microorganisms at different doses significantly affected the growth rate of tilapia. Further testing using the Tukey W-method showed differences between treatments B and C, D, and E, but similar to treatment A.

The results showed that treatment D, a feed supplemented with 25% fermented duck bone meal, produced the highest specific growth rate of 4.796±0.10. Treatment E (30% fermented duck bone meal) and treatment C (20% fermented duck bone meal) showed no significant differences, at 4.330±0.07 and 4.142±0.12, respectively. However, both treatments differed significantly from treatment A (10% fermented duck bone meal) and treatment B (15% fermented duck bone meal), which produced lower specific growth rates of 3.411±0.07 and 3.529±0.09, respectively.

Treatment D produced the highest SGR value of 4.796±0.10, indicating that 25% is the optimal dose. This is likely due to increased nutrient availability, such as protein and minerals, resulting from the fermentation process, which facilitates digestion and absorption (Kallau, 2018). Conversely, treatment E (30%) saw a decrease in SGR to 4.330±0.07, possibly due to excess minerals or decreased feed palatability.

This phenomenon is consistent with the principle of the nutrient response curve, where increasing the dosage of additives is only effective up to a certain optimum point, after which it causes negative impacts (Ahmadi, 2017). Therefore, a dosage of 25% can be considered the optimal level that has a positive impact on tilapia growth, making fermented duck bone meal an efficient and functional alternative feed ingredient when used appropriately.

Feed Consumption

Based on the analysis of variance (ANOVA) results, feeding duck bone meal fermented with a mixture of microorganisms at different doses significantly affected (P<0.005) the feed consumption of tilapia. A further W-Tuckey test showed that feeding duck bone meal fermented with a mixture of microorganisms in treatments C and D was the same but different from treatments A, B, and E.

The results showed that feed consumption values of tilapia (*Oreocromis niloticus*) were shown over 30 days when feeding duck bone meal fermented with a mixture of microorganisms at different doses. The highest to lowest feed consumption values obtained were treatment D (25% fermented duck bone meal) (11.73±0.30), followed by treatment C (20% fermented duck bone meal) (11.45±0.22), treatment E (30% fermented duck bone meal) (10.99±0.40), treatment A (10% fermented duck bone meal) (10.36±0.46), and B (15% fermented duck bone meal) (10.00±0.80).

The increase in feed consumption in treatments C (20%) and D (25%) is thought to be related to improved feed quality due to duck bone meal fermentation. The fermentation process produces flavor compounds such as organic acids and simple peptides that enhance palatability (Hossain et al., 2021). In addition, fermentation also increases digestibility and reduces anti-nutritional compounds, so that the feed is more preferred by fish (Kim et al., 2020).

However, in treatment E (30%), feed consumption decreased to 10.99 ± 0.40 g. This decrease was likely due to increased ash content and changes in the texture of the feed to a harder one, thus reducing digestibility and palatability (Sundu *et al.,* 2018). Thus, fermented bone meal levels of 20–25% were shown to significantly increase feed consumption, with the 25% level (treatment D) showing the best results due to the balance between aroma, digestibility, and nutrient content that supports the appetite of tilapia.

Hepatosomatic Index

The results of the analysis of variance (ANOVA) showed that the provision of fermented duck bone meal significantly affected the hepatosomatic index of tilapia (P<0.005). The Tukey W-test showed that the fermented duck bone meal differed between treatments D and A, but remained the same in treatments A, B, and E.

The results showed that the hepatosomatic index of tilapia (*Oreocromis niloticus*) reared for 30 days fed fermented duck bone meal varied from highest to lowest in treatment A (3.11±0.32), followed by treatment B (2.49±0.39), treatment D (2.05±0.08), treatment C (2.04±0.08), and treatment E (1.92±0.01).

The highest HSI value was found in treatment A, at 3.11 ± 0.32. This was caused by fat accumulation in the liver, triggered by high fat content in the feed or stress. According to Azizi *et al.* (2022), the fish liver plays a crucial role in energy metabolism and storage, including fat. When high-fat feed is provided or fish experience stress, fat reserves in the liver increase, resulting in an increased HSI value. Furthermore, this increase in HSI is also related to the vitellogenesis process, the egg maturation stage in female fish that requires more intensive liver activity to produce vitellogenin. Similarly, Ibrahim *et al.* (2020) stated that HSI can be used as an indicator of energy reserves in the liver and increases when vitellogenesis activity is higher compared to other treatments.

Conversely, the lowest HSI value was found in treatment E, at 1.92 ± 0.01. This low value is suspected to be due to nutritional imbalances or poor feed quality, which inhibit liver growth. Solhi *et al.* (2021) explained that increased metabolism typically increases energy and cellular nutrition, encouraging liver cell proliferation. However, if nutrition is inadequate or the diet is unbalanced, fat reserves in the liver will be used to meet energy needs, particularly during reproduction. Furthermore, a plant-based diet high in carbohydrates can also burden the liver's metabolism, thus affecting HSI values.

CONCLUSION

The research results concluded that duck bone meal can be a local raw material that can be used as a protein source in fish feed. Treatment D = 25% fermented duck bone meal produced the best results, containing a high protein content of 38.72%, contributing to high specific growth rates and feed consumption levels in tilapia. This combination of percentages excels in increasing growth and feed consumption levels in tilapia.

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