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Pengaruh penambahan tepung biji trembesi (*Samanea saman*) terfermentasi yoghurt dalam pakan terhadap protein efisiensi rasio dan laju pertumbuhan ikan nila (*Oreochromis niloticus*) dalam wadah terkontrol

The effect of fermented raintree (*Samanea saman*) seed meal with yoghurt in feed on protein efficiency ratio and growth rate of tilapia (*Oreochromis niloticus*) in controlled containers

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Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh penambahan tepung biji trembesi (*Samanea saman*) yang difermentasi dalam pakan terhadap protein efisiensi rasio dan laju pertumbuhan ikan nila (*Oreochromis niloticus*). Penelitian ini menggunakan Rancangan Acak Lengkap (RAL) yang terdiri dari 5 perlakuan dengan 3 kali ulangan. Analisis data hasil penelitian menggunakan ANOVA (analysis of variance) pada taraf 5%, dilanjutkan dengan uji Duncan. Perlakuan A; kadar tepung biji trembesi tanpa fermentasi (kontrol), Perlakuan B; kadar tepung biji trembesi terfermentasi yoghurt 4 mL/100g, Perlakuan C; kadar tepung biji trembesi terfermentasi yoghurt 6 mL/kg pakan, perlakuan D; kadar tepung biji trembesi terfermentasi yoghurt 8 mL/kg pakan dan Perlakuan E; kadar tepung biji raintree terfermentasi yoghurt 10 mL/kg pakan. Parameter utama yang diamati adalah protein efisiensi rasio dan laju pertumbuhan panjang dan bobot harian. Hasil penelitian menunjukkan bahwa penambahan tepung biji trembesi yang difermentasi dalam pakan menunjukkan protein efisiensi rasio dan laju pertumbuhan panjang dan bobot harian lebih baik jika dibandingkan dengan perlakuan tanpa penambahan tepung biji trembesi terfermentasi dalam pakan. Protein efisiensi rasio dan laju pertumbuhan panjang dan bobot harian terbaik diperoleh pada perlakuan penambahan tepung biji raintree terfermentasi 4 mL/ kg dalam pakan ikan nila *O. niloticus*.

Kata kunci: *Fermentasi; Oreochromis niloticus; Protein efisiensi rasio; Samanea saman; Yogurt*

Abstract

This study aims to determine the effect of adding fermented raintree (*Samanea saman*) seed meal to the feed on the protein efficiency ratio and growth rate of Nile tilapia (*Oreochromis niloticus*). The study uses a Completely Randomized Design (CRD) consisting of 5 treatments with 3 replications. Data analysis was performed using ANOVA (analysis of variance) at a 5% significance level, followed by Duncan's test. Treatment A: non-fermented raintree seed meal (control), Treatment B: raintree seed flour fermented with 4 mL/100g of yoghurt, Treatment C: raintree seed meal fermented with 6 mL/kg of yoghurt, Treatment D: raintree seed meal fermented with 8 mL/kg of yoghurt, and Treatment E: raintree seed meal fermented with 10 mL/kg of yoghurt. The main parameters observed were protein efficiency ratio and daily growth rate in length and weight. The study results indicated that the addition of fermented raintree seed meal in the feed showed a better protein efficiency ratio and daily growth rate in length and weight compared to the treatment without the addition of fermented raintree seed flour in the feed. The best protein efficiency ratio and daily growth rate in length and weight were obtained with the addition of 4 mL/kg of fermented raintree seed meal in the feed of Nile tilapia (*O. niloticus*).

Keywords: Fermentation; Oreochromis niloticus; Protein efficienci ratio; Samanea saman; Yoghurt

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1. Introduction

Oreochromis niloticus is a flagship commodity of aquaculture in Indonesia due to its high market demand. This is supported by the delicious and savoury taste of Nile tilapia (*O.*

niloticus) (Pattipeiluhu et al., 2023). The farming system is also relatively easy, as it can be cultivated on small household-scale land and a large industrial scale. One of the advantages of Nile tilapia farming is its wide tolerance to changes in water quality and high growth rate (Safsafubun et al., 2023). Several factors influence growth, one of which is the protein efficiency ratio. This is strongly supported by good feed quality. High-quality feed includes complete and balanced nutritional content, according to the fish's needs, and contains optimal total energy to support the fish's growth rate (Melanie et al., 2023 & Sihombing et al., 2023).

Fish growth is closely related to protein availability in the feed (Djalil et al., 2022). Khaeriyah et al. (2020) reported that the protein efficiency ratio is one aspect of the assessment of high-quality feed. The need for protein and fish growth has a linear relationship, so the protein content and protein energy ratio in the feed must absolutely match the fish's needs to ensure the feed is efficiently consumed to support optimal growth (Fahrudin et al., 2023).

Raintree seeds are a raw material containing quite high protein at 40.1% (Anwar et al., 2023) and are very potent as aquaculture feed. Furthermore, it has been reported that the nutritional quality of raintree seed meal can be enhanced through fermentation with the help of enzymes. Typically, enzymes produced during fermentation match those in the fish digestive tract, such as amylase, lipase, protease, and cellulase.

Yoghurt is a fermented milk product containing bacteria-producing microbes (Silva et al., 2012). These bacteria are important for digestion, such as lactic acid bacteria, L*actobacillus bulgaricus, Streptococcus thermophilus*, and *L. delbrueckii* (Pelczar et al., 1986), and have been used worldwide as probiotic supplements for humans and cultured organisms. Murni et al. (2018) reported that vegetable waste meal fermented using microbes could enhance its nutritional value and was effective as shrimp feed. Furthermore, Wang et al. (2023) reported that commercial feed fermented using microbes resulted in significantly better shrimp growth performance compared to non-fermented feed.

The objective of this study is to obtain the best protein efficiency ratio to support the growth of Nile tilapia by adding yoghurt-fermented raintree seed meal to the feed. The results of this research are expected to provide scientific information to stakeholders for the sustainable production of Nile tilapia using feed made from raintree seed meal.

2. Materials and Methods

2.1. Preparation

Nile tilapia measuring 2-3 cm, totalling 120 fish, were obtained from BBAP Takalar and then acclimated in the laboratory for 2 hours to adjust to the temperature and environment. The raintree seeds were collected from Antang Subdistrict, Makassar City, by gathering mature seeds that had fallen to the ground. The research was conducted in several stages: producing a raintree seed meal, fermenting the raintree seed flour, formulating the feed, and determining the best concentration using the protein efficiency ratio test and the growth rate of Nile tilapia.

2.2. Producing raintree seed meal

The raintree fruit was peeled, and the seeds were extracted. The seeds were then sun-dried until they reached a dryness level of 90%. Subsequently, the raintree seeds were ground using a Philips HR 2221 blender at a speed of 30,000 RPM and sieved to a size of 60 mesh.

2.3. Fermentation of raintree seed meal

One kilogram of raintree seed meal was evenly sprayed with yoghurt according to the treatment using a sprayer. The mixture was then placed into airtight clip-seal plastic bags. The bags were stored in a box to ensure a consistent room temperature and then fermented for three days. After the fermentation process, the raintree seed meal was steamed at 60°C for one minute to stop enzyme activity and then cooled to room temperature. The fermented product was then analyzed at the Feed Chemistry Laboratory, Faculty of Animal Science, Hasanuddin University.

2.4. Feed formulation

The study used a formulated feed with a 30% protein composition. The feed formulation included 20% fish meal, 20% raintree seed flour, 10% shrimp meal, 20% cornmeal, 20% rice bran, 4% fish oil, 3% mineral mix, and 3% vitamin mix. The preparation of the test feed began by grinding all dry ingredients. All ingredients were weighed according to the treatment and placed in plastic bags. The feed mixing started by combining small amounts of fine ingredients followed by larger quantities of raw materials, mixing thoroughly. Fish oil, mineral mix, and vitamin mix were then added. After thorough mixing, approximately 150 ml of warm water was added to the feed mixture to form a dough/paste. The feed dough was mixed until it no longer stuck to the hands. The dough was then placed into a pellet-making machine and formed into pellets suitable for the Nile tilapia's mouth size during the study. The pellets were evenly spread on trays and sun-dried until they reached a dryness level of 90%. The dry feed was placed into labelled plastic bags and stored in a dry place.

2.5. Protein efficiency ratio

The protein efficiency ratio (PER) is calculated using the following formula by Tacon (1993):

$$\text{PER} = \frac{Wt - Wo}{pi} x100$$

Notes:
PER = Protein Efficiency Ratio
Wt = Final fish biomass (g)
Wo = Initial fish biomass (g)
Pi = Amount of feed consumed x protein content (%)

2.6. Daily growth rate of length

The daily growth rate of length is calculated by measuring the fish length at the beginning and end of the rearing period. The formula used for calculating the daily growth rate of length according to Sari et al. (2017) is:

$$DL = \frac{Ln\ Lt\ -\ LnLO}{t} x\ 100$$

Note:
DL = Daily growth rate of length (mm/day)
Lt = Average fish length at the end of rearing (mm)
Lo = Average fish length at the beginning of rearing (mm)
t = Duration of rearing (days)

2.7. Feed conversion ratio

The feed conversion ratio (FCR) is calculated by comparing the total amount of feed given during rearing to the total wet weight gain of the fish. The FCR formula used by Anand et al. (2018) is:

$$FCR = \frac{\text{total feed applied}}{\text{total wet weight gain}}$$

2.8. Research design

The research design used was a Completely Randomized Design (CRD), with 4 treatments and three replications. The doses for each treatment are as follows:
Treatment A: Raintree seed meal without yoghurt (control)

Treatment B: Raintree seed meal + yoghurt (4 mL/kg)
Treatment C: Raintree seed meal + yoghurt (6 mL/kg)
Treatment D: Raintree seed meal + yoghurt (8 mL/kg)
Treatment E: Raintree seed meal + yoghurt (10 mL/kg)

2.9. Data analysis

Analysis of research data using one-way ANOVA and if there is an effect, it will be continued with ANOVA with a level of 5%, using the SPSS version 26 program.

3. Results and Discussion

3.1. Result

The research results showed the protein efficiency ratio of Nile tilapia fed with fermented and non-fermented raintree seed meal, as presented in Figure 1. Based on the analysis of variance, Nile tilapia fed with yogurt-fermented raintree seed flour significantly affected the protein efficiency ratio (P<0.05). Duncan's post-hoc test indicated that the protein efficiency ratio of Nile tilapia with the addition of 4 mL/kg of feed in Treatment B was significantly higher than the other treatments. Conversely, the feed without the addition of fermented raintree seed meal in Treatment A was significantly lower than the other treatments.

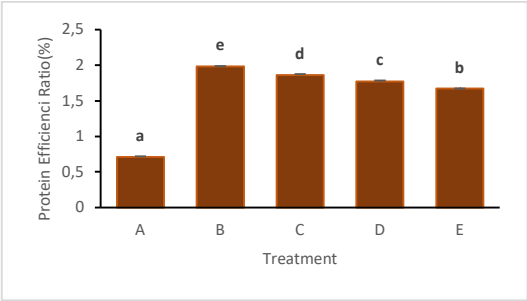

Figure 1. Protein efficiency ratio.

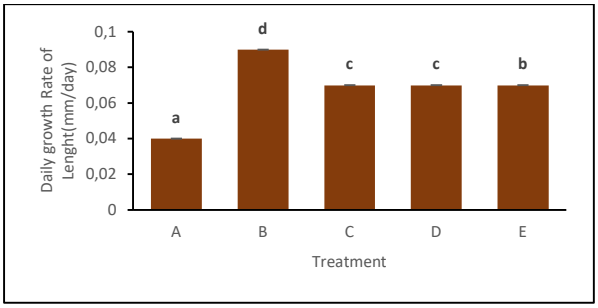

Figure 2. Daily growth rate of length.

The research results for the daily growth rate of length showed the Nile tilapia fed with fermented and non-fermented raintree seed meal, as presented in Figure 2. Based on the analysis of variance, Nile tilapia fed with yogurt-fermented raintree seed meal had a significant effect (P<0.05) on the daily growth rate of length. Duncan's posthoc test indicated that the daily growth rate of length of Nile tilapia with the addition of 4 mL/kg of feed in Treatment B was significantly higher than the other treatments. Conversely, the feed without the addition of fermented raintree seed meal in Treatment A was significantly lower than the other treatments.

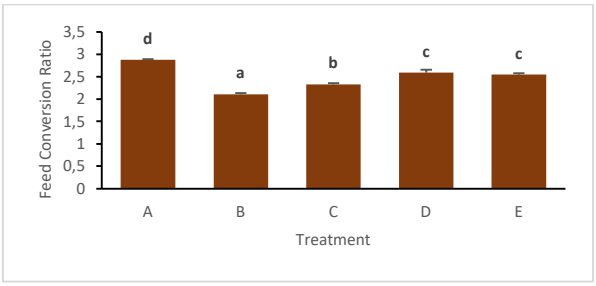

Figure 3. Feed conversion ratio.

Based on the analysis of variance, Nile tilapia fed with yogurt-fermented raintree seed meal had a significant effect (P<0.05) on the feed conversion ratio (Figure 3). Duncan's post-hoc test showed that the feed conversion ratio of Nile tilapia with the addition of 4 mL/kg of feed in Treatment B was significantly lower than the other treatments. Conversely, the feed without the addition of fermented raintree seed meal in Treatment A was significantly higher than the other treatments.

3.2. Discussion

The concentration of raintree seed meal fermented with yoghurt has certain limitations in producing an optimal protein efficiency ratio. It was found that increasing the dose of yoghurt beyond 4 mL/kg as a fermentation agent in the feed resulted in a lower protein efficiency ratio. The concentration of yoghurt in the feed as a fermentation agent is believed to significantly affect the performance of *Lactobacillus* and *Streptococcus thermophilus* microbes. These microbes produce digestive enzymes such as protease, amylase, lipase, and cellulase. Adding more than 4 mL/kg of yoghurt to the feed is suspected to exceed the optimal enzyme dose for hydrolyzing the feed. As explained by Anwar et al. (2023), the effectiveness of microbial fermentation rates is highly supported by the suitability of the amount of substrate and enzymes.

Generally, the feed fermentation process, with the correct dose and duration, produces significantly better feed quality compared to non-fermented feed (Azrita et al., 2023 & Safir et al., 2023). The study results show that a concentration of 4 mL/kg of feed produces the best nutritional quality. Conversely, increasing the concentration results in lower feed quality, as evidenced by lower protein efficiency ratios, feed conversion ratios, and daily growth rates of length.

The control treatment resulted in the lowest protein efficiency ratio compared to other treatments. This indicates that feed without the addition of microbes as a fermentation agent shows lower quality. This is demonstrated by the inability of Nile tilapia to efficiently utilize the protein contained in raintree seeds to support the daily growth rate of length. This is also consistent with the high feed conversion ratio observed during the study. The feed conversion ratio is inversely related to the growth rate and protein efficiency ratio.

Similarly, it was reported that a yoghurt concentration of 4% in broiler chicken feed improved growth performance and intestinal bacterial populations, as well as blood biochemical parameters (Ghasemi-sadabadi et al., 2019). Sribounoy et al. (2021) also reported that adding probiotics to commercial feed improved growth performance, and immune systems, and increased the economic value for Nile tilapia farmers in Jerusalem. It is believed that the enzymes in yoghurt optimally hydrolyze feed proteins, allowing nutrients to be utilized effectively by Nile tilapia to support their growth performance. Protein in feed is essential for metabolism and growth. If more protein is consumed in the feed, it will be stored by the fish as energy for growth after being used for metabolism. Conversely,

if the feed protein is insufficient, it will hinder the fish's metabolism and growth.

4. Conclusion

A concentration of 4 mL/kg of yoghurt as a fermentation agent in raintree seed meal feed is effective in improving the protein efficiency ratio, daily growth rate of length, and feed conversion ratio of Nile tilapia (*O. niloticus*).

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