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THE EFFECT OF USING PALM FROND FLOUR AS A FEED INGREDIENT ON THE GROWTH OF TILAPIA (*OREOCHROMIS NILOTICUS*, LINNEAEUS 1758)

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Abstrak

Constraints in cultivation activities include the high cost of feed. Feed constitutes a crucial factor in the growth of Nile tilapia, contributing to around 60-70% of the production expenses. The research aims to determine the effect of using palm oil frond flour as feed material on the growth of Nile tilapia (*O. niloticus*). The study was conducted from July to September 2022. The organism used in the study was Nile tilapia fry (*O. niloticus*). This research employed a Completely Randomized Design (CRD) consisting of 5 treatments with 4 replications each. Treatment A: 0% palm oil frond flour + 100% corn flour, Treatment B: 25% palm oil frond flour + 75% corn flour, Treatment C: 50% palm oil frond flour + 50% corn flour, Treatment D: 75% palm oil frond flour + 25% corn flour, and Treatment E: 100% palm oil frond flour + 0% corn flour. The research findings indicate that Treatment C (50% palm oil frond flour + 50% corn flour) provided the best results in Nile tilapia growth, including daily specific growth rate (2.77%), absolute weight (4.23g), feed conversion ratio (0.9), and survival rate (97.5%).

Keywords: Growth; Palm Flour; Palm Frond; Tilapia

INTRODUCTION

Nile tilapia (*O. niloticus*) is one of the freshwater species currently highly sought after by communities as a source of animal protein. Besides its distinctive and nutritious flesh (Rieuwpassa et al., 2020), this fish demonstrates relatively fast growth and relatively easy breeding and maintenance (Chavan & Yakupitiyage, 2012; Orlando et al., 2017). Therefore, the cultivation of Nile tilapia continues to evolve with various systems (Albani et al., 2023), aimed at achieving high production to provide relatively affordable and fast animal protein for the community. Nevertheless, the development of various growth systems for Nile tilapia is generally constrained by the consistently rising cost of feed. This is due to the raw materials for macro nutrients in feed production, which are typically utilized by humans as staple foods such as soybeans, corn, and fish, leading to an increase in their economic value.

Several researchers have attempted to develop self-made feeds using local non-economic materials (Oktapiani et al., 2021; Safir et al., 2022; Safir et al., 2020) in an effort to reduce feed costs. However, the availability of these local materials has not yet met the requirements for feed production. Therefore, ongoing research focuses on finding potential non-economic local materials as alternative feed ingredients.

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Palm oil frond is an abundant waste product of the palm oil industry and lacks economic value. Preliminary tests on palm oil frond in powdered form indicate a protein content of 4.25%, carbohydrate content of 81.30%, fat content of 1.37%, and ash content of 3.96%, with a moisture content of 9.12%. Studies on the utilization of palm fronds as feed ingredients have reported positive effects on ruminants (Pranata, 2019; Rizali et al., 2018). The existence of palm oil fronds and their nutritional content suggests their potential use as feed material, particularly for herbivorous aquatic organisms, including Nile tilapia. Hence, due to the lack of information on this matter, this research aims to demonstrate that the use of palm oil frond flour can be employed as a feed ingredient to promote growth in the cultivation of Nile tilapia (*O. niloticus*).

MATERIAL AND METHODS

Animal Test

The test organisms used were juvenile Nile tilapia (*O. niloticus*) with a weight of 2.03±0.31 g and a length of 5.22±0.25 cm. The Nile tilapia were obtained from the Fish Seed Center (Balai Benih Ikan - BBI) in Mpanau, Karajalemba, Palu City, Central Sulawesi.

Preparation of palm frond flour

Oil palm fronds are obtained from community-owned oil palm plantations in Lariang District, Pasangkayu District, West Sulawesi. The frond of the oil palm is separated between the inside and the outside (the skin). Furthermore, the inside is taken and cut into small pieces, then dried (moisture content <12%). Shortly after drying, followed by smoothing using a grinding machine. Fine and coarse particles of the grinding results are separated by sieving (0.5 mm mesh size). The fine particles resulting from the sieve were then fermented using probiotics (Effective Microorganism 4; EM4) at a dose of 80 mL/kg of material. The fermentation process begins by dissolving 80 mL of probiotic in 1 liter of water, then mixing it with 1 kg of palm frond flour, then placing it in a container (black bucket) and tightly closing it to prevent air from entering the container. After 14 days, the fermented product is then dried using a tray until the moisture content is <12% and ready to be used.

Formulation and Production of Test Feed

The feed was made according to the treatment tested, namely the use of palm frond flour as a substitute for corn flour. Treatments A (0%), B (25%), C (50%), D (75%) and E (100%) were respectively from corn flour (Table 1). The detail of treatment adalah A) use of 0% palm frond flour + 100% corn flour; B) palm frond flour 25% + 75% corn flour; C) palm frond flour 50% + 50% corn flour; D) palm frond flour 75% + 25% corn flour; E) palm frond flour 100% + 0% corn flour.

The Seybold Report

ISSN 1533-9211

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Tabel 1: Komposisi bahan baku pakan perlakuan

No.	Material	Treatment/composition of feed ingredients (g)				
		A	B	C	D	E
1.	Fish flour	15	15	15	15	15
2.	Soy flour	15	15	15	15	15
3.	Shrimp head flour	25	25	25	25	25
4.	Palm frond flour	0	3	6	9	12
5.	Cornstarch	12	9	6	3	0
6.	Bran flour	18	18	18	18	18
7.	Palm oil	2	2	2	2	2
8.	Fish oil	3	3	3	3	3
9.	Tapioca flour	7	7	7	7	7
10.	Mixed vitamins & minerals	3	3	3	3	3
	Total	**100**	**100**	**100**	**100**	**100**

The method of feed preparation in this study followed the approach of Safir et al. (2022), where separation of liquid and flour raw materials was performed. The flour raw materials were initially mixed in small percentages followed by larger ones (Table 1). Subsequently, the homogenously mixed feed material in flour form was slowly added to a container containing a mixture of oils (fish and palm oil), while stirring continuously until homogenous. Once all the ingredients were mixed, warm water (approximately 45°C) was gradually added (30% per kg of ingredients) to form a dough. The dough was then shaped and dried directly under sunlight. After the feed was dried, 100 g samples were analyzed for proximate composition to confirm the nutritional content of the test feed (Table 2), while the rest were ready for use.

Nutrient Content (%)	Test Feed				
	A	B	C	D	E
Water	13.4	9.41	10.49	6.16	9.63
Fat	7	11.21	11.67	14.27	13.69
Proteins	21.22	24.47	22	21.76	20.29
Ash	10.77	10.91	10.77	11.48	11.08

Maintenance of Test Organisms

The adapted test fish, consisting of 10 individuals, were placed into each 16 L container filled with 10 L of water and equipped with aeration systems to supply oxygen after a 24-hour adaptation period. Each treatment was replicated four times. The test fish were kept for a duration of 42 days. Feeding was provided three times a day (at 08:00, 12:00, and 16:00 WITA), allowing them to eat as much as they wanted. Weighing the test fish was done weekly during the rearing period. The water quality in the rearing environment was maintained within suitable ranges for Nile tilapia growth (temperature 25-32°C; pH 6.5-8.5; dissolved oxygen ≥3 mg/L; and ammonia ≤1 mg/L) (Chavan & Yakupitiyage, 2012; SNI, 2009) by regularly monitoring water quality. Removal of feces and leftover feed, as well as water replacement, were conducted periodically.

The Seybold REPORT
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Observed Variables and Data Analysis

Specific daily growth rate, individual weight gain, feed conversion ratio and survival of the test fish were calculated by referring to the equation used by Muchlisin et al. (2017) and Safir et al. (2023). The data obtained were analyzed using ANOVA (one-way) and Duncan's further test at the 95% level of confidence.

Daily Specific Growth Rate

$$\mathrm{DSGR} = \frac{\mathrm{Ln}\overline{\mathrm{W_t}} - \mathrm{Ln}\overline{\mathrm{W_o}}}{\Delta t} \times 100\%$$

Where:

DSGR = Daily Specific Growth Rate (%/day);

$\mathrm{Ln}\overline{\mathrm{W_t}}$ = The average natural logarithm of fish biomass at the end of the study (g).

$\mathrm{Ln}\overline{\mathrm{W_o}}$ = The average natural logarithm of fish biomass at the beginning of the study (g).

Δt = Time observation difference (days).

Individual Weight Gain

$$\mathrm{W} = \overline{Wt} - \overline{W0}$$

Where:

W = **Individual weight gain** (g),

$\overline{Wt}$ = The average weight of fish at the end of rearing (g),

$\overline{W0}$ = The average weight of fish at the beginning of rearing (g).

Feed Conversion Ratio (FCR)

Feed conversion ratio (FCR) can be calculated by the following formula:

$$\mathrm{FCR} = \frac{F}{(Wt + D) - Wo}$$

Where:

F = Total feed given during the study (g); Wo = Initial fish weight (g); Wt = Final fish weight (g); D = Weight of fish that died during the rearing period (g).

Survival Rate (SR)

$$\mathrm{SR} = \frac{N_t}{N_o}\ x\ 100\ \%$$

Where: SR = Survival Rate (%) Nt = Number of fish at the end of rearing (individuals) No = Number of fish at the beginning of rearing (individuals)

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RESULTS AND DISCUSSION

Daily Specific Growth Rate (DSGR)

The specific growth rate obtained over the 42-day rearing period showed the highest value in treatment C (50% palm oil frond flour + 50% corn flour) at 2.77 g and the lowest in treatment A (0% palm oil frond flour + 100% corn flour) at 1.9 g. Based on the analysis of variance (ANOVA) results, it was found that the administration of palm oil frond flour at different doses in the feed significantly affected the specific growth rate of Nile tilapia ($P<0.05$). Further Duncan's multiple range test showed that treatment C significantly differed from all other treatments, treatment D significantly differed from treatments A, B, and E, while treatments A, B, and E exhibited similar effects. The results of the specific growth rate are presented in Figure 1.

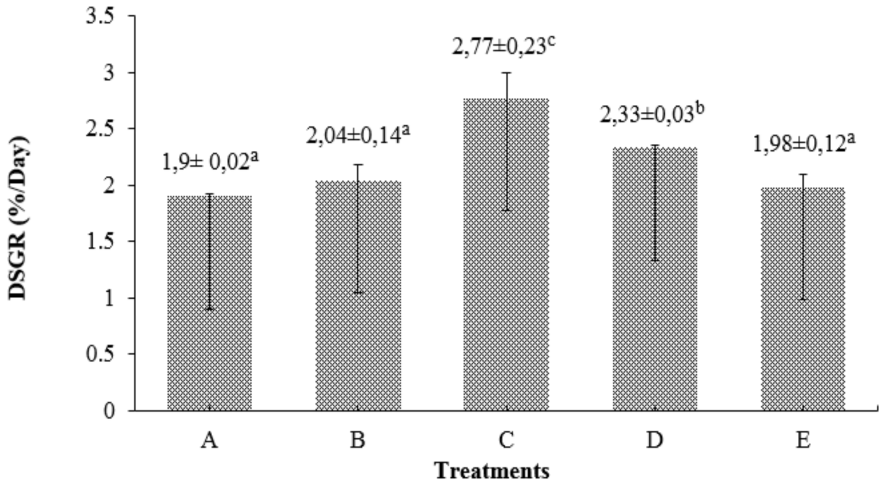

Figure 1: Daily Specific Growth Rate (DSGR) of Nile Tilapia from Treatments

The daily specific growth rate of Nile tilapia exhibited an increase with the inclusion of palm oil frond flour in the feed up to a 50% dosage, followed by a decline with the inclusion of palm oil frond flour at a 100% dosage. This indicates that there are limitations in the test fish's ability to utilize palm oil frond flour in the feed.

The high dosage of palm oil frond flour is believed to elevate the lignin content present in the feed, thereby affecting the digestion process and resulting in lower growth of Nile tilapia. According to Jayanegara et al. (2019), lignin is a component of antinutritional substances that influences the digestion process in livestock. The lignin content in palm fronds ranges between 18-33% (Arpinaini et al., 2017). Furthermore, the low daily specific growth rate in the control treatment (without palm oil frond flour) is possibly due to the phytic acid content in the feed derived from the use of corn flour. According to Yanuartono et al. (2017), raw materials like corn contain antinutritional substances that can reduce feed digestibility. This, in turn, limits the absorption of other nutrients such as amino acids, carbohydrates, and minerals into the body (Hidayat, 2016).

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Additionally, the balance of amino acids in the feed is also crucial for Nile tilapia growth. An amino acid imbalance in the feed leads to decreased fish growth because excessive amino acid intake can be toxic (DKP, 2013).

Absolute Weight Growth

The absolute weight growth of Nile tilapia during the 42-day rearing period exhibited the highest value in Treatment C (50% palm oil frond flour + 50% corn flour), at 4.23 g, and the lowest in Treatment E (100% palm oil frond flour + 0% corn flour), at 2.36 g. Based on the analysis of variance (ANOVA), the provision of palm oil frond flour at different dosages in the artificial feed significantly affected ($P<0.05$) the absolute weight growth of Nile tilapia. Further Duncan's post hoc test results indicated that Treatment C significantly differed from all other treatments, while Treatment B significantly differed from Treatments A, D, and E. Treatments A and D did not exhibit significant differences, but they were different from Treatment E. The absolute weight growth results are presented in Figure 2.

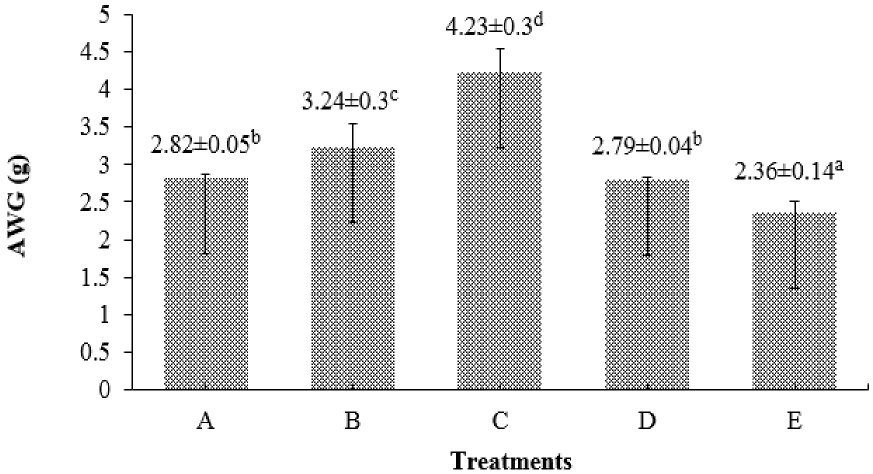

Figure 2: Absolute Weight Growth of Tilapia Result of Treatment

The absolute weight growth of juvenile Nile tilapia exhibited an increase when fed with a diet containing palm oil frond flour up to a 50% dosage. However, there was a subsequent decline in growth as the palm oil frond flour dosage was increased to 100%. This pattern suggests limitations in the test fish's ability to effectively utilize palm oil frond flour as a feed ingredient.

With higher dosages of palm oil frond flour, it is hypothesized that the elevated lignin content within the feed may hinder the digestion process, resulting in lower growth rates for the Nile tilapia. According to Febrina et al. (2015), palm oil fronds contain a lignin content of 30.18%. Elevated lignin levels often correlate with reduced feed digestibility in organisms (Imsya and Palupi, 2009), potentially explaining the observed decrease in growth. Conversely, the lower weight growth observed in the control treatment (which did not include palm oil frond flour) could be attributed to the presence of phytic acid in the feed derived from the use of corn flour. Bidura (2017) suggests that antinutritional factors, including phytic acid, can negatively impact

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feed utilization, ultimately leading to growth and health-related issues if their content within the consumed feed is substantial.

Furthermore, the balance of amino acids within both palm oil frond flour and corn may significantly influence the weight growth of Nile tilapia. Poto (2019) highlights that a well-balanced ratio of essential and non-essential amino acids is essential for promoting fish growth.

Feed Conversion Ratio (FCR)

The feed conversion ratio of Nile tilapia during the 42-day rearing period displayed the lowest value in treatment C (50% palm oil frond flour + 50% corn flour), which was 0.9, and the highest value in treatment E (100% palm oil frond flour + 0% corn flour), which was 1.91. The analysis of variance (ANOVA) results indicated a significant effect ($P<0.05$) of different dosages of palm oil frond flour in the artificial feed on the feed conversion ratio of Nile tilapia. Further Duncan's post hoc test revealed that treatment E significantly differed from all other treatments, while treatment A significantly differed from treatment C, but did not show a significant difference with treatments B and D. The feed conversion ratio results are presented in Figure 3.

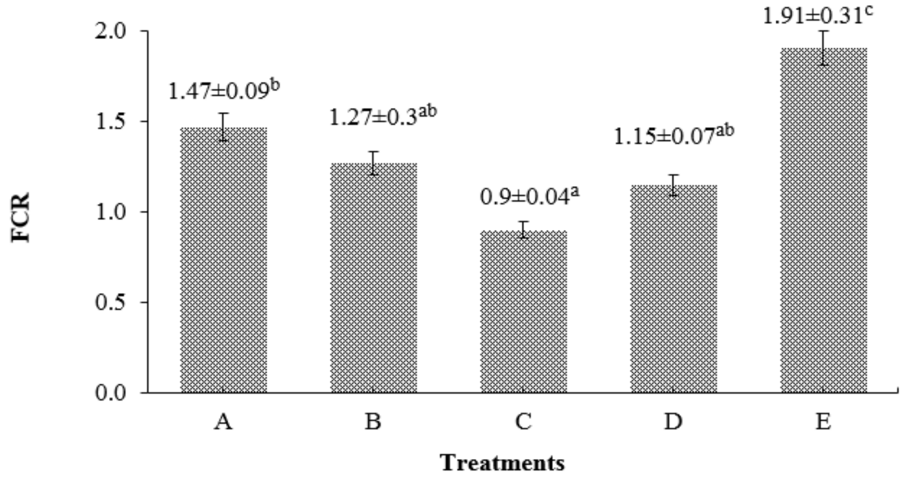

Figure 3: Feed conversion ratio of treated Tilapia

The feed conversion ratio of Nile tilapia exhibited a decrease with the inclusion of palm oil frond flour in the feed up to a dosage of 50%, followed by an increase as the dosage of palm oil frond flour was further raised to 100%. A lower feed conversion ratio indicates effective utilization of nutrients provided in the feed by Nile tilapia. A lower value of the feed conversion ratio signifies better feed utilization, while a higher value suggests suboptimal feed utilization for the growth of Nile tilapia (Iskandar and Elrifadah, 2015).

The feed conversion ratio is closely related to the growth rate and weight gain of fish, where the calculated value determines the quality of the feed in terms of supporting growth. Fish growth is significantly influenced by the type of feed provided. The high dosage of palm oil frond flour is believed to elevate the lignin content, potentially affecting the digestion process

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in Nile tilapia, consequently leading to higher feed conversion ratios. In the control treatment (without palm oil frond flour), the feed conversion ratio also increased, presumably due to the presence of phytic acid in the feed sourced from the use of corn flour.

Survival Rate (SR)

Kelangsungan hidup ikan nila selama pemeliharaan 42 hari menunjukkan nilai tertinggi pada perlakuan C (tepung pelepah kelapa sawit 50% + 50% tepung jagung) yaitu 97,5% dan terendah pada perlakuan A (tepung pelepah kelapa sawit 0% + 100% tepung jagung) yaitu 77,5%. Hasil kelangsungan hidup tertera pada Gambar 4.

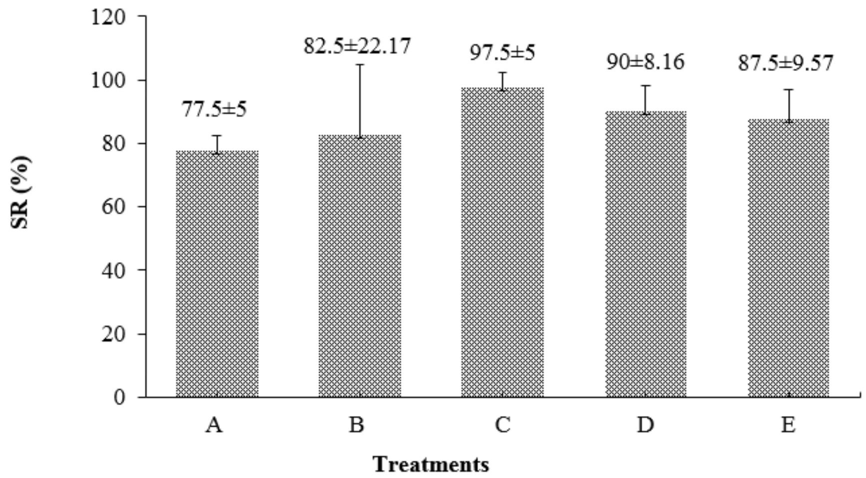

Figure 4: Survival of treated tilapia

The survival rate of Nile tilapia demonstrated an increase with the inclusion of feed containing palm oil frond flour up to a dosage of 50%, followed by a decline as the dosage of palm oil frond flour was increased to 100%. This indicates that some Nile tilapia were unable to survive throughout the rearing period.

One of the factors influencing the survival of an organism is the environment (Suriadi, 2019). The highest fish mortality occurred during the initial phase of rearing, which is suspected to be due to the process of adaptation to the new environment and adjustment to the test feed, leading to stress, as well as handling during fish weighing. According to Karimah et al. (2018), the survival of Nile tilapia is greatly determined by the environment, with most deaths occurring due to stress and the varying resilience of each individual fish.

CONCLUSION

The highest daily specific growth rate, absolute weight growth, survival rate, and lowest feed conversion ratio were obtained in the treatment with a dosage of 50% palm oil frond flour + 50% corn flour, sequentially measuring 2.77% per day, 4.23 g, 97.5%, and 0.9, respectively.

The Seybold REPORT

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