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# Increasing Local Biomass Waste for Independent Fish Feed Production

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***ABSTRACT***

Bengkulu Province has extensive potential in the fisheries, agriculture, and forestry sectors. However, the fisheries sector currently faces a dependency on commercial feed. The use of waste materials is expected to reduce dependence on commercial feed. The research method used was a Completely Randomized Design with several research treatments. In this study, the best treatment was the use of Fermented Vegetable Waste + 15% Fermented Coffee Husk (B2), which showed quite efficient FCR, SGR, and PER results.

## INTRODUCTION

Bengkulu Province, which spans an area of approximately 19,788.70 square kilometers, possesses significant natural resource potential, particularly in the fisheries, plantation, and forestry sectors. This natural wealth plays a crucial role in supporting the regional economy, which can be empirically measured through the Gross Regional Domestic Product (GRDP). As evidence of this tangible contribution, according to a study by Lestari et al., (2022), the combined contribution of the fisheries, agriculture, and forestry sectors accounted for 28.36% of the total RDP of Bengkulu Province in 2020. This region's comparative advantage in the agriculture and forestry sectors is supported by the presence of various strategic commodities. Furthermore, the primary commodities driving these subsectors include horticultural crops (vegetables) and high-value plantation crops such as coffee and oil palm.

The fisheries sector is one of the strategic pillars with highly promising growth prospects within the regional economic landscape. In particular, the aquaculture sub-sector offers the assurance of sustainable aquatic resources, provided that a comprehensive and optimal management system is in place. Empirical evidence of the high viability of this sector can be seen in the escalation of fisheries production performance in Bengkulu Province. Referring to the findings of Anggrini et al., (2023), the volume of aquaculture production in the region reached a significant figure of 229,048 tons in 2021. This figure represents a positive growth trend of 1.34% when compared to the total production output in 2020, which stood at 226,005 tons. Furthermore, the substantial production capacity in Bengkulu Province is closely tied to the support provided by the local area's spatial and geographical characteristics. Bengkulu Province's location directly on the western coast of Sumatra Island and facing the open waters of the Indian Ocean provides a fundamental comparative advantage for the development of its fisheries sector (Samsudin, 2021)

The high production in the agricultural and forestry sectors in the province is also directly proportional to the resulting biomass waste. Currently, post-production waste is simply disposed of with little use. The accumulation of post-production waste that is not properly managed can cause environmental damage and air pollution (Putri et al., 2024). On the other hand, the aquaculture sector in Bengkulu Province faces challenges, one of which is increasing dependence on commercial fish feed. Commercial feed alone can account for approximately 60-70% of total production costs. This situation is exacerbated by disruptions in the global supply chain, which impact the availability and prices of raw fish feed ingredients (Rochman et al., 2014). Therefore, efforts to produce independent feed in Central Java are currently being intensified. Bengkulu Province, with its agricultural potential, can be used as an alternative source of raw materials for independent feed production.

Optimizing the utilization of agricultural and plantation byproducts is an urgent strategic step that must be implemented. Various organic residues, such as vegetable waste, coffee processing waste, and even palm kernel cake, actually hold significant potential to be engineered into valuable new resources. The conversion of these organic materials is projected to serve as a comprehensive solution to the problem of post-harvest production waste accumulation, which is prone to triggering environmental degradation. On the other hand, integrating these post-harvest byproducts into aquaculture feed offers an essential breakthrough for the development of the aquaculture sector. The use of these alternative raw materials is expected not only to optimally stimulate fish growth performance but also to significantly reduce farmers' reliance on high-cost commercial feed. The synergy between sustainable waste management and this self-sufficient feed innovation is expected to have a direct impact on improving operational efficiency while boosting the competitiveness and market value of aquaculture products. Therefore, empirical studies on the formulation and effectiveness of utilizing these wastes as fish feed components are crucial to conduct in order to provide a scientific foundation for sustainable aquaculture practices.

## METHOD

This research was conducted at the Fisheries Laboratory, Freshwater Fisheries Cultivation Study Program, Rejang Lebong State Community Academy, from September to October 2025. The research design used was a Completely Randomized Design (CRD). The treatment in this study was the utilization of biomass waste in Rejang Lebong with the following treatments:

K1 : 17% protein pellets
K2 : 34% protein pellets
A1 : Fermented vegetable waste + fermented coffee husks + 10% fermented palm kernel meal
A2 : Fermented vegetable waste + fermented coffee husks + 15% fermented palm kernel meal
B1 : Fermented vegetable waste + 10% fermented coffee husks
B2 : Fermented vegetable waste + 15% fermented coffee husks
C2 : Fermented vegetable waste + 15% fermented palm kernel meal
D2 : Fermented vegetable waste 15%

This study aims to observe the growth of tilapia fish in the use of biomass waste in Rejang Lebong. Each treatment was replicated three times and placed randomly. The tools and materials used during the study were: Aquarium measuring 30 x 20x30, blower, aeration stone, do meter, thermometer, pH meter, fish scoop, bucket, digital scale, tilapia seeds, vegetable waste flour, palm kernel meal flour, and coffee skin waste. Fish seeds were put into each aquarium 30 fish and maintained for 30 days. Feeding was 5% of the total biomass per day with a frequency of 2 times a day. Feed performance tests included evaluation of Feed Conversion Ratio (FCR), specific growth rate (SGR), Protein Efficiency Ratio (PER) and survival rate (SR) in test fish for 40 days. The research data were analyzed statistically using analysis of variance (ANOVA) with the F test at a 95% confidence level through the help of SPSS 20 software. If the analysis showed a significant effect, then a further Duncan test was carried out to determine the real difference between the treatments given.

## RESULT AND DISCUSSION

| Parameter | Feed treatment | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | K1 | K2 | A1 | A2 | B1 | B2 | C2 | D2 |
| SR (%) | 83.89±0.96$^{d}$ | 82.22±0.96$^{cd}$ | 73.89 ±1.92$^{a}$ | 80.56±4.81$^{bc}$ | 77.78±4.81$^{bc}$ | 75.00±0.00$^{ab}$ | 80.56±4.81$^{bc}$ | 83.33±1.92c$^{d}$ |
| SGR (%BW/day) | 1.25±0.16$^{a}$ | 1.34±0.23$^{a}$ | 1.83±0.43$^{b}$ | 1.26±0.25$^{a}$ | 1.42±0.21$^{bc}$ | 2.33±0.26$^{c}$ | 1.13±0.10$^{a}$ | 1.41±0.23$^{bc}$ |
| FCR | 2.55±0.11$^{c}$ | 2.51±0,40$^{bc}$ | 1.91±0,31$^{ab}$ | 2.67±0,56$^{c}$ | 2.33±0,34b$^{c}$ | 1.62±0.15$^{a}$ | 2.91±0.15$^{c}$ | 2.47±0.36$^{bc}$ |
| PER | 1.12±0.49$^{a}$ | 1.16±0.18$^{a}$ | 1.53±0.27$^{b}$ | 1.10±0.21$^{a}$ | 1.24±0.17$^{ab}$ | 1.77±0.16$^{c}$ | 0.98±0.52$^{a}$ | 1.17±0.17$^{a}$ |

* Note :
K1(17% protein pellets);
K2 (34% protein pellets);
A1 (Fermented vegetable waste + fermented coffee husks + 10% fermented palm kernel meal);
A2 (Fermented vegetable waste + fermented coffee husks + 15% fermented palm kernel meal;
B1 (Fermented vegetable waste + 10% fermented coffee husks);
B2 (Fermented vegetable waste + 15% fermented coffee husks);
C2 (Fermented vegetable waste + 15% fermented palm kernel meal);
D2 (Fermented vegetable waste 15%)

The results of the study showed that the feeding treatments provided significantly different growth responses and feed efficiency in the test fish. The highest survival rates (SR) were obtained in treatments K1 (83.89%) and D2 (83.33%), which were not significantly different from treatments K2 and C2. Meanwhile, the lowest SR was found in treatment A1 (73.89%), which was significantly different from most other treatments. These findings indicate that the type of feed in treatment A1 was less than optimal in maintaining fish survival. The difference in results in the survival rate of the test fish may be caused by the nutritional content of the feed provided. According to the report results (Simamora et al., 2021) Survival rates can be influenced by feed. Proper feeding, with attention to nutritional content, feed size, and daily quantity, will significantly impact fish metabolism, which in turn impacts the survival of farmed fish. Besides feed, fish survival rates can be influenced by other factors, such as the organism's ability to adapt and environmental conditions (Akbar et al., 2020). Overall, the survival rate at the time of the study showed favorable results. This is in accordance with the statement (Budiraharjo & Pangastuti, 2017) Where survival results ≥ 50% are classified as good, while survival between 30-50% is moderate and survival ≤ 30% is classified as low.

The specific growth rate (SGR) showed significant variation among treatments. The highest value was achieved in treatment B2 (2.33%/day), followed by A1 (1.83%/day), which differed significantly from the other treatments. Conversely, the lowest SGR values were found in treatment C2 (1.13%/day) as well as K1 and A2, which also showed relatively slow growth. This confirms that the feed in treatment B2 was able to contribute the most to fish biomass growth. Nile tilapia is classified as omnivorous fish with a tendency toward herbivory. This aligns with the statement by Wagaw et al., (2022), which notes that during the juvenile stage, Nile tilapia are omnivorous and consume aquatic animals such as insects, phytoplankton, and zooplankton. However, as they mature, tilapia tend to consume plant-based food sources. Therefore, the use of plant-based feed ingredients demonstrates a relatively high growth rate compared to the control treatment. The specific growth rate of fish is the percentage of daily growth calculated based on the weight of the test fish (Akbarurrasyid et al., 2021). The rate of fish growth is significantly influenced by the quality and quantity of feed provided. In addition to feed, the environmental conditions where the fish live play a crucial role in stimulating fish growth (Yanuar, 2017). According to Francisca & Muhsoni, (2021), fish growth can occur when nutritional needs are met. Most nutrients will be used to meet energy needs. Once energy is met, fish will use excess nutrients for metabolism and growth.

Feed efficiency, measured through the Feed Conversion Ratio (FCR), showed that treatment B2 had the best FCR (1.62), followed by A1 (1.91). The highest (worst) FCR value was found in treatment C2 (2.91), indicating that more feed was needed to produce the same weight gain compared to other treatments. In general, treatments with a high SGR tend to show a better FCR, indicating more optimal feed utilization efficiency. FCR, or feed conversion ratio, is an indicator in determining feed effectiveness. FCR can also be interpreted as the ability of a cultured species to convert feed into meat. A lower FCR value indicates a more effective feed conversion into meat compared to unutilized feed (Azima, 2023). The type and quality of feed provided can affect the FCR value in cultured fish. The nutritional content of feed, especially protein and digestibility, are key factors in high and low FCR values in aquaculture. However, high nutritional value alone is not enough to reduce the FCR value in aquaculture. Water quality also affects the FCR value in cultured fish (Ramadhan & Haetami, 2025).

The Protein Efficiency Ratio (PER) provides additional insight into protein utilization. The highest PER value was also found in treatment B2 (1.77), followed by A1 (1.53), indicating that both treatments maximized the conversion of feed protein into biomass. The lowest PER value was found in treatment C2 (0.98), indicating low protein utilization efficiency. This pattern aligns with the low FCR and SGR results in these treatments. Overall, treatment B2 performed best in growth and feed efficiency parameters, followed by treatment A1. Conversely, treatment C2 tended to produce the lowest performance in most parameters. These findings confirm that the feed formulation in treatment B2 is the most effective choice for increasing growth, survival, and nutrient utilization efficiency by fish. PER in fish feed is a measure of how effectively protein in the feed is converted into fish body weight growth. This is consistent with a report (Pratama & Pinandoyo, 2015) that feed with energy that meets the needs of farmed fish can increase the PER value. This is because the protein content in the feed can be optimally utilized by the body for the growth process. The PER value can be influenced by the fish's ability to digest food. A fish's ability to digest feed can be influenced by several factors, such as feed composition and the protein content of specific feed ingredients (Wulanningrum et al., 2019).

The fermentation of feed ingredients has been widely recognized as an effective biotechnological strategy for enhancing growth rates and nutrient digestibility in farmed fish. The basic principle of fermentation relies on the activity of microorganisms capable of degrading indigestible feed components into simpler compounds that are easily absorbed by the fish's digestive system, while simultaneously improving overall nutritional value (Andriani & Pratama, 2022). The fermentation process has been shown to increase the content of essential amino acids and functional biomolecules that play a crucial role in supporting optimal fish growth performance. Furthermore, fermentation breaks down complex carbohydrates into compounds with lower molecular weights, thereby increasing the availability of metabolic energy and making mineral absorption by the fish's body more efficient (Gule & Geremew, 2022). The application of fermentation to feed ingredients has also been shown to effectively reduce the content of antinutritional compounds, such as tannins, phytates, and protease inhibitors, which are known to hinder the optimal utilization of nutrients by fish. Furthermore, fermentation contributes to an increase in the population of beneficial microbiota in the fish's digestive tract, which in turn stimulates digestive enzyme activity and ultimately significantly improves digestive efficiency and nutrient absorption (Siddik et al., 2024).

## CONCLUSION

Based on the results of the research and discussion, the conclusions that can be drawn include: The best treatment is treatment B2 (Addition of fermented vegetable waste + 15% fermented coffee skin). This can be seen from the results of observations of the highest SGR, FCR and PER parameters. The use of treatment B2 showed the highest specific growth rate (2.33 ± 0.26) as well as a low feed conversion ratio (1.62 ± 0.15) and a fairly high protein efficiency (1.77 ± 0.16) when compared to other treatments. It is hoped that this research can be used as a consideration in making an independent feed to reduce dependence on commercial feed.

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