

Improving Liquid Organic Fertilizer Made from Fish Waste by Adding Papaya Leaves

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ABSTRACT

Papaya leaves contain the enzyme papain which can help microorganisms degrade collagen and elastin in fish waste, thus accelerating the hydrolysis of protein into amino acids and free nitrogen. The research aims to analyze the effect of adding papaya leaves with various concentrations and fermentation times on increasing the volume and quality of liquid organic fertilizer made from fish waste. This research was conducted at the Integrated Laboratory of Lambung Mangkurat University in Banjarbaru, Indonesia. This study used a factorial randomized block design with two factors, namely the concentration of papaya leaves (0 g, 30 g, 60 g, and 90 g) and the fermentation time (3, 7, and 14 days). The addition of papaya leaves in the fermentation process of liquid organic fertilizer (LOF) from fish waste had an effect on increasing the volume of LOF the highest was obtained on the 14th day with the addition of 30% papaya leaves, while the highest nitrogen and phosphorus content was achieved in fermentation for seven days with a concentration of 10–20%.

Keywords: *Liquid Organic Fertilizer, Fish Waste, Papaya Leaves*

INTRODUCTION

Fishery waste includes the remains of fish cleaning and processing, including meat

flakes, scales, fins, skin, bones, guts, shells, and wastewater from fish washing. Suppliers of fishery waste include the fishing industry, micro, small, and medium enterprises producing processed fish products, processing and marketing groups, and traditional markets. This fishery waste is an area that has not been optimally utilized by some fishery businesses (Arrasiksycan et al. (2023).

In addition to being used as animal feed, fish waste can be used as an ingredient in silage (Sofia et al., 2021), fish sauce (Gasperzs et al., 2023); Eगतama (2023) note that this processing involves fermenting fish waste with the addition of other organic materials, resulting in a liquid fertilizer with high nutritional content, a balanced pH, and a distinctive aroma.

Murdaningsih & Rahayu (2022) stated that liquid organic fertilizer (LOF) made from fish waste contains essential nutrients that can be absorbed by plants, including 0.30% nitrogen (N), 0.65% phosphorus (P), and 0.17% potassium (K). All of these elements are stimulants that support the growth of plants. Liquid organic fertilizer is generally produced through the fermentation process of organic matter with the help of anaerobic microorganisms that decompose organic matter into essential plant nutrients, such as nitrogen (N), phosphorus (P), and potassium (K) (Apriani et al. (2023).

Preliminary survey results at Banjarbaru Market indicate that the amount of waste from fish harvesting reaches 35 kg per day, equivalent to 1,050 kg per year. Currently, this waste is only used as animal feed. These survey results indicate significant potential for processing fishery waste generated at Bauntung Market in Banjarbaru City into an economic resource for the community, in addition to animal feed, by processing it into liquid organic fertilizer.

Lepong Bulan (2017) and Suartini (2018) reported that the fermentation time required to produce liquid fertilizer from fish waste is approximately 10 to 14 days. The success of the fermentation process is greatly influenced by the available substrate and environmental conditions that support the growth of the microorganisms used. The fermentation process for organic fertilizer made from fish waste takes approximately 14 days. During this period, microorganisms break down the organic matter in the fish waste into nutrients that are more easily absorbed by plants (Rafidah et al., 2023).

The advantage of organic fertilizer is its ability to address nutrient deficiencies in the soil by providing nutrients that are quickly absorbed by plants. However, there are still drawbacks to providing organic fertilizer, namely the need for a fermentation process that tends to require a suitable fermentation container and a relatively long fermentation time. The availability and activity of protein-degrading enzymes are among the factors influencing the fermentation process of fish waste into liquid fertilizer. Therefore, the addition of protease enzymes during fermentation will act as a catalyst in the process of producing organic liquid fertilizer, accelerating biochemical reactions and the decomposition of organic matter from fish waste. Protease enzymes accelerate fermentation and increase the efficiency of converting organic matter into nutrients needed by plants (Atma, 2016).

Therefore, the application of protease enzymes in the production of liquid organic fertilizer is expected to produce high-quality

products in a shorter time. Furthermore, the use of this liquid fertilizer will increase agricultural productivity and environmental sustainability. Affordable and readily available natural sources of protease enzymes include papaya sap, papaya fruit and leaves, pineapple fruit and stems, and ficus fruit (Putra et al., 2022).

Papaya leaves contain the enzyme papain, which can help microorganisms degrade collagen and elastin in fish waste, thereby accelerating protein hydrolysis into amino acids and free nitrogen. Nitrogen content in fertilizer is one indicator of its quality (Suartini, 2018). The use of crushed papaya leaves as a natural source of protease enzymes to enhance the production of liquid organic fertilizer from fish waste. The addition of papaya leaves is expected to accelerate the fermentation process while improving the overall quality of the fertilizer. Fertilizer quality is evaluated based on its nitrogen (N), phosphorus (P), and potassium (K) content. The research specifically aims to analyze the effect of varying concentrations of papaya leaves and different fermentation durations on both the volume and nutrient quality of the resulting liquid fertilizer.

MATERIALS & METHODS

Research Location and Time

This research was conducted at the Integrated Laboratory of Lambung Mangkurat University, Banjarbaru, Indonesia. The research timeframe was adjusted to accommodate the stages of material preparation, fermentation, and laboratory analysis.

Experimental Design

The study used a factorial Randomized Block Design (RBD) with two factors:

- Factor A: Papaya leaf concentration (0 g, 30 g, 60 g, and 90 g)
- Factor B: Fermentation duration (3 days, 7 days, and 14 days)

Each treatment was replicated three times to obtain a representative treatment combination.

Liquid Organic Fertilizer Production Procedure

- The main ingredient is cleaned fish stomach waste.
- Salt, at 10% of the material weight, was added as a pretreatment to inhibit the growth of undesirable microorganisms.
- Crushed papaya leaves were added according to the treatment (0%, 10%, 20%, and 30% of the fish waste weight).
- The mixture was homogenized and placed in a sealed container.
- Fermentation was carried out anaerobically for 3, 7, and 14 days, depending on the treatment.

Observation Parameters

The parameters observed included:

- Volume of liquid organic fertilizer produced

- Macronutrient content, namely nitrogen (N), phosphorus (P), and potassium (K).
Data Analysis Method
- Descriptive analysis was used to describe the average values, data trends, and changes in the volume and content of N, P, and K in each treatment.
- Inferential analysis was conducted using analysis of variance (ANOVA) to determine the significant effect of each factor and their interactions.

RESULT

After 3, 7, and 14 days of fermentation, the liquid organic fertilizer could be taken. The volume of fermentation results (in milliliters) Table 1:

Table 1. Volume of Liquid Organic Fertilizer with Papaya Leaves

Day (Group)	10%	20%	30%	Control
3	150	150	150	155
	151	149	151	154
	149	151	151	156
7	190	191	210	156
	192	190	211	154
	191	190	211	155
14	220	240	279	180
	221	241	280	181
	219	240	280	179
Fermentation Time	Papaya Leaf Volume			
	Control	10 %	20%	30%
3	155 mL	150 mL	150 mL	151 mL
7	155 mL	191 mL	190 mL	211 mL
14	180 mL	220 mL	240 mL	280 mL

Table 1 shows that both fermentation time and papaya leaf concentration influence the volume of liquid organic fertilizer produced. At day 3, the volumes across all treatments (control, 10%, 20%, and 30%) were relatively similar, ranging from 150–155 mL, indicating that the fermentation process had not yet progressed sufficiently to create noticeable differences among treatments. By day 7, an increase in volume was observed in all treatments; however, the increase was more pronounced in treatments with papaya leaf addition, particularly at 30% concentration (211 mL), compared to the

control, which remained relatively stable (155 mL). This suggests that the presence of papaya leaves began to enhance the decomposition process during the mid-fermentation stage. On day 14, the differences became more substantial, with the highest volume recorded in the 30% treatment (280 mL), followed by 20% (240 mL), 10% (220 mL), and the control (180 mL). This pattern clearly indicates that higher concentrations of papaya leaves, combined with longer fermentation time, result in greater fertilizer volume. The increase in the control treatment also

confirms that fermentation alone contributes to volume enhancement, but at a slower rate compared to treatments with papaya leaves. Overall, these findings demonstrate that papaya leaves, as a source of protease enzymes, effectively accelerate the breakdown of organic matter, thereby increasing the production of liquid fertilizer, especially when applied at higher concentrations and longer fermentation periods. The test results are presented in Table 2.

Table 2. Two-way ANOVA Test Results on the Volume of Liquid Organic Fermentation Results with the Addition of Papaya Leaves

F	df1	df2	Sig.
.187	11	24	.997

Table 2 presents the results of Levene’s test, which was conducted to assess the homogeneity of variances for the volume of liquid organic fertilizer across different treatments and fermentation times. The test produced a significance value of 0.997 ($p > 0.05$), indicating that there is no significant difference in variance among the groups. This means that the assumption of homogeneity of variance has been met, and the data can be considered statistically uniform across all treatment combinations. Consequently, the dataset is suitable for further analysis using parametric tests such as two-way ANOVA, as the reliability of the results is not compromised by unequal variances. The data meets the homogeneity requirement, which is an important prerequisite in analysis of variance (ANOVA) in Table 3:

Table 3. Two-way ANOVA Test Results of the Volume of Liquid Organic Fermentation Results with the Addition of Papaya Leaves

Data Source	df	Middle Value	F	Sig.
Fermentation Time	2	18588.694	2.574	.000
Papaya Leaf Concentration	3	3874.111	5.364	.000
Fermentation Time × Papaya Leaf Concentration	6	1463.917	2.027	.000

The results of the two-way ANOVA in Table 3 indicate that both fermentation time and papaya leaf concentration have a significant effect on the volume of liquid organic fertilizer ($p < 0.05$). More importantly, a significant interaction between these two factors was also observed ($p < 0.05$), indicating that the effect of fermentation time on fertilizer volume is not independent but depends on the level of papaya leaf concentration applied, and vice versa. Due to this significant interaction, the interpretation cannot rely solely on the main effects of each factor; instead, it must consider the combined treatments of fermentation time and papaya leaf concentration. This suggests that increasing fermentation time may produce different outcomes at each concentration level, resulting in a non-linear and non-uniform response in fertilizer volume. This phenomenon highlights that papaya leaves,

as a source of protease enzymes, contribute to accelerating the decomposition of organic matter, but their effectiveness is influenced by the duration of fermentation. At certain fermentation periods, enzymatic activity may reach optimal conditions, leading to higher fertilizer volume, particularly at specific papaya leaf concentrations, while in other treatment combinations, longer fermentation does not necessarily result in a significant increase in volume. Therefore, the presence of a significant interaction confirms that determining the optimal conditions for producing liquid organic fertilizer requires consideration of the best combination of fermentation time and papaya leaf concentration, and it also suggests the need for further post hoc tests to identify which treatment combinations produce significantly higher fertilizer volumes. The data in Table 4 were then further tested to see the differences between

treatments in terms of time and papaya leaf concentration:

Table 4. Results of Two-way ANOVA Test on the Volume of Fermentation Results of Liquid Organic Fertilizer with the Addition of Papaya Leaves

Treatment	Average	Duncan Notation
Control	155.22	a
10%	163.44	ab
20%	163.67	ab
30%	170.67	b

The average results of observations for 3, 7, and 14 days, the administration of liquid organic fertilizer (LOF) from liquid fish waste with the addition of papaya leaves showed a trend of increasing parameter values as the concentration of treatment increased. The average value in the control treatment was 155.22, increasing to 163.44 at a concentration of 10%, 163.67 at 20%, and reaching 170.67 at 30%. The results of Duncan's further test showed that the control treatment had a different notation (a) compared to the 30% treatment (b), which indicated a statistically significant difference between the two treatments. Meanwhile, the 10% and 20% treatments had the same notation (ab), which indicated that both were not significantly different, either against the control or the 30%

treatment. Thus, it can be concluded that the administration of LOF with a concentration of 30% had a significant effect on increasing the observed parameters compared to the control, although the 10% and 20% treatments did not show a statistically significant difference. These findings support the hypothesis that increasing the concentration of LOF has the potential to increase fertilizer effectiveness, particularly at the 30% level. After observing the fermentation results of liquid organic fertilizer with the addition of papaya leaves, an analysis was conducted to determine the content of the main nutrients, namely nitrogen (N), phosphorus (P₂O₅), and potassium (K₂O).

The resulting volume can be seen in Figure 1:

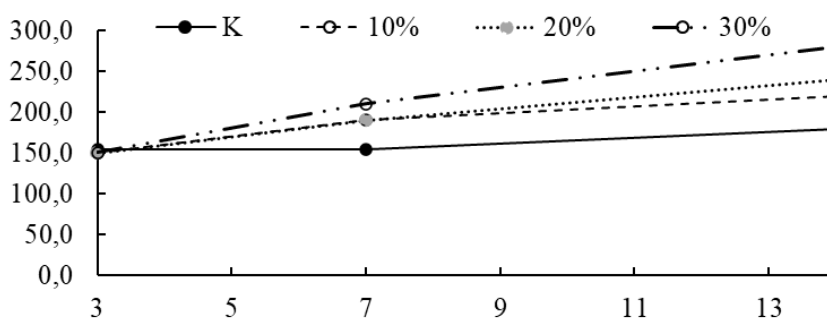


Figure 1. Papaya Leaves Graph of the Volume of Liquid Organic Fertilizer Results with the Addition of

Figure 1 shows a significant increase in the volume of organic fertilizer (LOF) between the papaya leaf-added treatment and the control (without papaya leaves), especially on days 7 and 14. On day 3, the LOF volume was relatively uniform (150-155 mL), indicating suboptimal decomposition. Entering day 7, the volume difference began to become apparent; the 10% and 20% treatments produced 163 and 164 mL,

respectively, while the 30% treatment yielded a significant increase to 171 mL, while the control remained at 155 mL. The highest volume was reached on day 14, reaching 191 mL, significantly higher than the other treatments and the control (155 mL). The 10% and 20% treatments produced 177 mL.

Liquid organic fertilizer (LOF) is an environmentally friendly solution that is

gaining popularity in sustainable agriculture due to its ability to improve soil fertility and structure, as well as provide essential micro and macro nutrients for plants. Liquid organic fertilizer is easy to apply by spraying or watering, making it practical and efficient for farmers. In its development, various additives are used to improve the quality and effectiveness of LOF, one of which is a combination of fish waste and young papaya leaves (*Carica papaya* L.). Fish waste provides essential nutrients, while papaya leaves contain the enzyme papain, which can accelerate the decomposition of organic matter. The use of papaya leaves as a natural activator in LOF fermentation aims to accelerate decomposition, increase the volume, nutrient content, and stability of the liquid fertilizer (Hapsari & Welasih, 2013). The process of making LOF from fish waste and papaya leaves involves selecting fresh fish waste and young papaya leaves that are bright green and intact. Fermentation was carried out for several days in a closed container with varying concentrations of papaya leaves (10%, 20%, and 30%), and observations were made on days 3, 7, and 14. During fermentation, microorganisms break down organic matter into simple, water-soluble compounds, producing a dark liquid with a distinctive aroma. The volume of LOF formed is an indicator of fermentation success. This increase is due to the enzymatic activity of papaya leaves, particularly the enzyme papain, which hydrolyzes proteins and accelerates the degradation of organic matter (Wicaksono & Rachmawati, 2022). In the production of liquid organic fertilizer (LOF) based on fish waste, differences in volume between treatments and controls are often caused by the absence of natural enzymes or additional green substrates in the control, which inhibit fermentation activity. The addition of papaya leaves as a green material has been shown to increase the volume of LOF produced. Research Putra & Ratnawati (2019) showed that fermentation of papaya fruit waste with the addition of

EM4 produced a higher nutrient concentration than without the addition. This suggests that manipulating the papaya leaf concentration and extending the fermentation time can increase the volume and quality of the resulting LOF.

The anaerobic fermentation process, which occurs in oxygen-depleted conditions, involves the activity of microorganisms in converting organic matter into organic acids and other nutrient compounds. This method is efficient in processing organic matter into a fertilizer rich in organic compounds and also has the potential to produce biogas as a useful byproduct. Furthermore, this process tends to be stable under extreme environmental conditions and can help extend the shelf life of the resulting fertilizer. Thus, the use of papaya leaves in anaerobic fermentation of fish waste not only increases the volume of organic fertilizer (LOF) but also enriches its nutritional content, making it an effective and environmentally friendly alternative for organic waste processing (Mulyono et al., 2023). Considering the important role of NPK elements previously described and the potential benefits of fish waste, the next step in this research is to test the NPK content in LOF. This test aims to determine the precise levels of each NPK element, allowing for a comprehensive evaluation of the quality and effectiveness of LOF produced from this fish waste as a sustainable organic fertilizer.

CONCLUSION

The addition of papaya leaves in the fermentation process of liquid organic fertilizer (LOF) from fish waste has an effect on increasing the highest LOF volume obtained on the 14th day with the addition of 30% papaya leaves, while the highest nitrogen and phosphorus content is achieved in fermentation for seven days with a concentration of 10–20%.

Declaration by Authors

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REFERENCES

1. Apriani, M., Setiani, V., & Thalib, F. N. (2023). Utilization of Papaya as a Biostarter in Composting Fish Waste and Mangrove Leaves Using Black Soldier Fly Larvae. *Journal of Environmental Pollution Control (JPPL)*, 5(1), 98–109. <https://doi.org/10.35970/jppl.v5i1.1703>
2. Arrasiksycah, K., Syaputra, D., & Kurniawan, A. (2023). The Effect of Rusip Liquid Biocatalyst Concentration in Reducing Fish Waste into Liquid Organic Fertilizer. *Al-Ard: Journal of Environmental Engineering*, 9(1), 26–36. <https://doi.org/10.29080/alard.v9i1.1796>
3. Atma, Y. (2016). Utilization of Fish Waste as an Alternative Source for Gelatin and Bioactive Peptide Production: A Review. *National Seminar on Science and Technology*, 1(1), 1–6.
4. Egatama, H. F. (2023). Making Organic Green Fertilizer from Papaya Leaves as a Fertilizer for Farmland in Monggol Village. *Jurnal Atma Inovasia*, 3(3), 270–276. <https://doi.org/10.24002/jai.v3i3.6056>
5. Gasperzs, F. F., Sormin, R. B. D., Mailoa, M. N., & Wali, R. (2023). THE PRESENCE OF LACTIC ACID BACTERIA IN TUNA (*Thunnus* sp) SAUCE DURING THE FERMENTATION PROCESS. *Jurnal Teknologi Produk Perikanan*, 03(2), 241–246.
6. Hapsari, N., & Welasih, T. (2013). Utilization of Fish Waste as Organic Fertilizer. *Journal of Environmental Engineering*, 2(1), 1–6. <https://core.ac.uk/download/pdf/12219482.pdf>
7. Mulyono, S. E., Riasih, T., Fajar, M., Candra, S., & Marga, U. P. (2023). Liquid organic fertilizer (LOF) is a fermented organic fertilizer in liquid form and has the advantage of being more easily absorbed by plants and containing rapidly available macro and micro nutrients. *Journal of Civilization*, 3(5), 2021–2024.
8. Murdaningsih, & Rahayu, P. S. (2022). APPLICATION OF FISH WASTE LIQUID ORGANIC FERTILIZER ON CUCUMBER (*Cucumis Sativus* L.) PLANTS. *Murdaningsih. AGRICA: Journal of Sustainable Dryland Agriculture*, 14(1), 1–10.
9. Putra, B. W. R. I. H., & Ratnawati, R. (2019). Production of Liquid Organic Fertilizer from Fruit Waste with the Addition of Bioactivator EM4. *Journal of Environmental Science and Technology*, 11(261), 44–56.
10. Rafidah, Ayu Apriliyanti, Hidayat, & Zaenab. (2023). Utilization of Fish Waste as Liquid Organic Fertilizer (LOF) with the Addition of Pineapple Peel and Rice Washing Water. *Jurnal Sulolipu: Media Komunikasi Civitas Akademik dan Masyarakat*, 23(2), 261–273.
11. Ranasinghe, A., Jayasekera, R., Kannangara, S., & Rathnayake, S. (2019). Effect of Nutrient-Enriched Organic Liquid Fertilizers on the Growth of *Albemonchus esculentus*. *Journal of Environmental Protection and Sustainable Development*, 5(3), 96–106.
12. Sofia, A., Nugroho, B. E. L., Maulana, M. A., Silviawati, P. A., Ramadhan, S., & Sari, Y. (2021). APPLICATION OF BIOTECHNOLOGY IN MAKING TRASH FISH SILAGE THROUGH LACTIC ACID BACTERIAL FERMENTATION. *Jurnal Akuakultura*, 5(1), 10–16.
13. Suartini, K., Abram, P. H., & Jura, M. R. (2018). Production Of Liquid Organic Fertilizer from Skapsan Fish Offal Waste (*Katsuwonus pelamis*). *Jurnal Akademika Kimia (Jurnal Akademika Kimia)*, 7(2), 70–74. <https://doi.org/10.33536/jcpe.v3i1.193>
14. Wicaksono, G. D., & Rachmawati, S. H. (2022). NPK Analysis of Liquid Organic Fertilizer from Tilapia Fish Waste Using Local Microorganisms from Papaya Peel. *Jurnal FishtechH*, 11(1), 47–57. <https://doi.org/10.36706/fishtech.v11i1.17540>

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