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Turning Trash into Treasure: How Composting and Eco-enzymes Can Revolutionize Waste Management and Add Value

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Abstract

Managing organic waste through composting and eco-enzyme production offers environmental and economic advantages. Composting reduces methane emissions, enhances soil quality, and boosts agricultural yields, while eco-enzymes provide a novel waste management solution. This study compares the added value of food and garden waste in eco-enzyme and compost production, emphasizing their potential for sustainable resource utilization and economic gain. The research involves waste collection, production, quality analysis, and added value assessment. Compost and eco-enzymes are made from various waste compositions, with quality analysis covering nutrient content and enzyme activity. Economic analysis highlights the viability of composting and eco-enzyme production. Despite challenges such as low material content and unexpected water increase with EM4, both methods show promise. Composting yields IDR2,142.86 with a 65% added value ratio, while eco-enzymes earn IDR69,964 with a 94% ratio, offering benefits like room freshening and higher profits.

Keywords: Add value, compost, eco-enzymes, waste.

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INTRODUCTION

Most human activities produce waste. According to Marliani (2015), waste is material thrown away without use or commercial value. The problem in Indonesia is a matter of great concern because waste is not managed in a certain amount, and concentration can result in adverse environmental impacts (Hendri et al., 2018).

Based on the origin and constituent components, it can be divided into organic and an-organic waste. Organic waste is approximately 47.7% of the total waste (Kementerian Lingkungan Hidup dan Kehutanan, 2023). This category primarily comprises food waste, including fruits and vegetables (40.1%) and garden waste (wood and leaves, 7.6%). Food waste is the third biggest problem out of 15 environmental problems in 2024 (Robinson, 2024). All components of this organic waste can be biodegraded. Components that can be bio-degraded have the potential to become a source of nutrients that can enrich soil with macro and micronutrients, produce humus, and improve soil quality (Nur et al., 2016). Some efforts can be made to utilize organic waste and add value by converting it into compost and eco-enzymes (Arun & Sivashanmugam, 2015).

Biological processes in food waste management are a clear example of how economic value can be generated through a sustainable approach. When people throw away unused food, it often ends up in landfills, producing harmful biogas such as methane, contributing to climate change (Safdie, 2023). However, by understanding the principles of biology, food waste for economic gain can be utilized. By applying biological principles such as the ability to decompose by microbes or soil enzymes, food waste can be converted into nutrient-rich compost (Srinivasrao et al., 2017). This compost can be an effective organic fertilizer to improve soil quality and agricultural yields. In addition, this process reduces waste and methane emissions, which are detrimental to the environment (Rahman et al., 2020).

Apart from ecological benefits, economic value is also realized through savings in waste management costs and increased agricultural productivity. Compost produced from food waste reduces the need for chemical fertilizers, potentially lowering costs for farmers (Pajura, 2024). Additionally, better crop yields and healthier agricultural products can generate higher incomes in the agricultural sector (Sholihah et al., 2020). Therefore, integrating biological processes in food waste management helps reduce environmental impacts and opens significant economic opportunities by reusing natural resources and increasing agricultural productivity.

The processing of organic waste into compost has been widely practiced and researched. Several studies have reported the benefits (added value) of organic materials

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processed into compost (Sayara et al., 2020). However, research on the added value of organic materials processed into eco-enzymes is still limited.

Eco-enzymes are liquid solutions produced through fermentation of complex organic compounds sourced from organic waste materials, such as fruits and vegetables, combined with water and sugar (Hemalatha & Visantini, 2020). The fermentation process lasts 90 days and involves basic components such as sugar/molasses, organic waste, and water in a ratio of 1:3:10 (Rochyani et al., 2020). According to Verma et al. (2019), liquid eco-enzymes produced through the fermentation process are dark brown and give off a sour and sweet aroma, characteristic of the fermented substance.

Eco-enzyme liquid consists of various secondary metabolite compounds produced by microorganisms, especially bacteria and fungi present during fermentation. Rochyani et al. (2020) identified secondary metabolites of enzymes such as amylase, trypsin, lipase, phenols, alcohols, and organic acids. One of the organic acids in eco-enzymes is acetic acid, produced by bacterial metabolism in fruit and vegetable residue (Larasati et al., 2020). Several studies that have been conducted show that in eco-enzymes, there are many microorganisms, including lactic acid bacteria (Ibrahim et al., 2015) and fungi (Aulia & Handayani, 2022). Various microbes in the fermentation liquid generate various enzyme activities in eco-enzymes.

Common organic materials for eco-enzymes are leftover vegetables and fruits (Novianti & Muliarta, 2021). The composition of the organic materials used to make eco-enzymes determines the dominant types of microbes in the eco-enzymes and influences the quality of the resulting eco-enzymes (Pace et al., 2018). It has not been studied whether leaves, as a primary component of garden waste, can be used for eco-enzymes. Since there is limited information on the utilization of food waste (vegetables and fruits) and garden waste as eco-enzymes, this research was conducted to compare the added value of food and garden waste as organic substrates for eco-enzymes and compost.

MATERIALS AND METHODS

Materials

Food waste (vegetables and fruit) was collected from cafes on the SWCU campus and in its vicinity, while garden waste was collected from the campus yard and other yards. The collected waste is weighed and divided as needed in eco-enzymes and compost. Other materials used in this experiment were goat manure, molasses, EM4 probiotics, scales, measuring cups, chopping equipment, mixing equipment, 10 kg containers, and 1600 mL plastic bottles.

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METHODS

This research consists of three stages: (1) waste collection and the production of eco-enzyme and compost, (2) analysis of the quality of eco-enzyme and compost, and (3) analysis of added value. The first stage of the research aims to determine the amount of food and garden waste that can be obtained daily and to make compost and eco-enzymes from this waste. The aims of this research's second and third stages are to determine the quality of compost and eco-enzymes and to analyze the added value of waste processed into compost and eco-enzymes.

Waste Collection and Compost and Eco-Enzyme Production

The collected garden waste is separated and weighed from plastic or organic waste, which is difficult to decompose (paper, cardboard, twigs). Food waste is separated and weighted separately. Waste weighing is carried out daily so that daily waste production is known. Waste is separated as needed and made into compost or eco-enzyme.

All organic food and garden waste materials were mixed with a 1:3 ratio and cut into 2 cm pieces to make compost. The research design was completely randomized with two factors: (1) the ratio of organic waste and goat dung and (2) the addition of EM4 as a stimulant. The ratio of organic waste and goat manure is made at three levels: (1) a ratio of 3:1 (K1), (2) a ratio of 1:1 (K2), and (3) a ratio of 1:3 (K3). Meanwhile, there are two levels of EM4 stimulant addition: (1) with EM4 addition (E1) and (2) without EM4 addition (E0). All treatments were repeated four times. According to their respective treatments, 7 kg of the mixture was placed in 10 kg containers with a lid. All containers were placed randomly and incubated outside of sunlight for 60 days.

Food waste is separated from garden waste, and an organic material composition treatment is carried out to make eco-enzymes. The organic materials composition treatments include using all food and garden waste and a 1:1 ratio of garden and food waste. All organic materials are cut into 2 cm pieces and then mixed with molasses and water in a ratio of 3 parts of organic material, 1 part of molasses, and 10 parts of water. This mixture was placed in a 1600 mL mineral water bottle. The total volume of eco-enzyme produced is 980 mL. All treatments were repeated 10 times, placed randomly, and incubated outside sunlight for 90 days (Novianti & Muliarta, 2021; Istanti & Utami, 2022).

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Compost and Eco-Enzyme Quality Analysis

Samples for compost quality analysis were prepared by drying the mature compost (60 days old). After air drying, the compost was crushed and sieved using a 2 mm sieve. Fine composts were used to determine the total N content (Kjedhal method), total P (HCl 25% soluble P method LPT 1971), total K (HCl 25% soluble K method LPT 1971), organic matter content (spectrophotometric methods), ash content (graphimetric techniques), water content by incineration at a temperature of 500°C for 3 hours (Jakobsen, 1995) and ratio C/N (Mustoyo et al., 2013).

Eco-enzyme samples were obtained from the filtered 90-day-old fermentation liquid. Eco-enzyme samples were used to determine the total N content (Kjedhal method), total P (HCl 25% soluble P method LPT 1971), total K (HCl 25% soluble K method LPT 1971), organic matter content (spectrophotometric methods), the activity of the enzyme's urease, cellulase, and amylase. Urease activity is determined according to Kandeler & Gerber (1988), cellulase activity is assessed based on endo-(1,4)-b-D-glucanase activity as described by Lokapirnasari et al. (2015), and amylase activity is measured using the amylase activity determination method (Bernfeld, 1955).

Waste Value-Added Analysis.

Analysis of the added value of waste was carried out using the Hayami et al. (1987) method. This method includes, among other things, calculating conversion factors, labor coefficients, output prices, and direct labor wages. From this added value analysis, the added value ratio, profit and profit level can be obtained (Table 1).

Table 1 ***Calculation of value added by the Hayami Method***

I. Output, Input and Price	
1. Total Output/Product (Kg/Production Process)	A
2. Raw Material Input (Kg/Production Process)	B
3. Labor Input (HOK/Production Process)	C
4. Conversion Factor (Kg Output/Kg Raw Material)	D = A/B
5. Labor Coefficient (HOK/Kg Raw Material)	E = C/B
6. Output Price (Rp/Kg	F
7. Labor Average Wages (IDR/Production Process)	G

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I. Output, Input and Price	
II. Acceptance and Profits	
8. Raw Material Input Prices (IDR/Kg)	H
9. Contribution of Other Inputs (IDR/Kg)	I
10. Output Value (IDRp/Kg)	J = D x F
11. Value Added (IDR/Kg)	K = J – H – I
- Value Added Ratio (%)	I% = K/J x 100%
12. Labor Income (IDR/Kg)	M = E x G
- Labor Share (%)	N% = M/K x 100%
13. Profit (IDR/Kg)	O = K – M
- Profit Rate (%)	P% = O/J x 100%
III. Reply to Owners of Factors of Production	
14. Margin (IDR/Kg)	Q = J – H
- Labor Income (%)	R% = M/Q x 100%
- Contribution of Other Inputs (%)	S% = I/Q x 100%
- Entrepreneur Profit (%)	T% = O/Q x 100%

Source: Hayami, et al. (1987)

Note. Where the test criteria are:

a) If the added value is > 50%, then the added value is said to be high.

b) If the added value is < 50%, then the added value is said to be low

RESULTS AND DISCUSSION

The Amount of Waste Collected and Its Use as Basic Material for Compost and Eco-Enzyme

Based on waste collection data from several locations, namely residential compounds, cafes, school canteens, food stalls, households, and schoolyards, data on the weight of waste is obtained as in Table 2. Some waste is collected in a day, but some is collected in more than a day.

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Table 2 ***Contribution of waste obtained from partners per activity unit and per day***

No	Partners	Activity (unit)	Average weight of waste per unit (kg.unit-1)	Average weight of waste per day (kg.day-1)
1	Residential compound	120	4.14	55.19
2	Cafe	1	317.00	22.64
3	School canteen	1	153.20	8.51
4	Food stalls	7	52.53	30.70
5	Household	1	12.6	4.20
6	Schoolyard	1	394.00	394.00

When comparing the amount of waste produced per unit of activity, it appears that the largest organic waste supply unit is school yards, namely 42%. Other activity units that produce quite a lot of organic waste are cafes (34%) and school canteens (16%) (Figure 1a). If we look at the average daily weight, food waste supplies 24% of organic waste (Figure 1b).

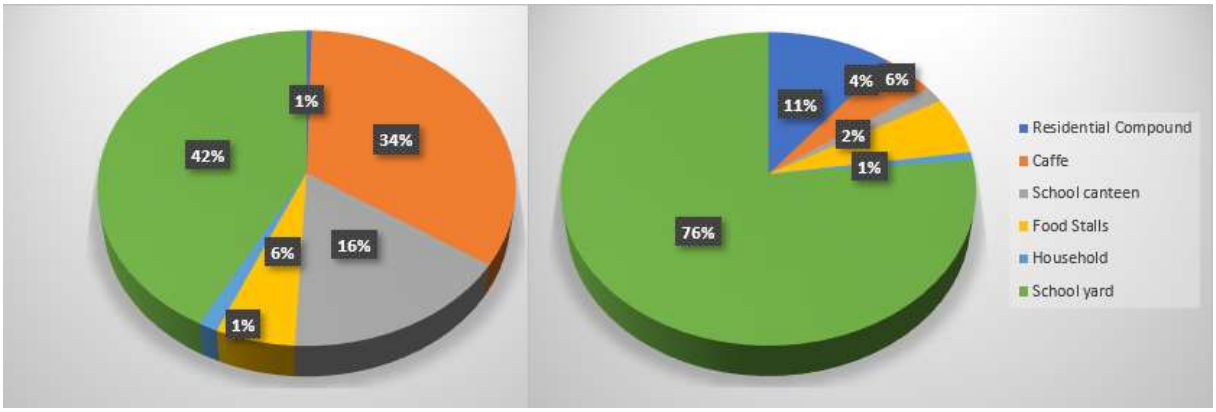


Figure 1. The percentage of waste weight from each source is based on activity unit (a) and daily waste supply (b)

Based on its shape, the form of waste from sources other than the schoolyard is wet food waste, while from the schoolyard, it is in the form of leaves or plant litter. This wet food waste has been separated into organic food waste only (not mixed with plastic, boxes, or bottles) and consists of vegetable scraps, fruit peels, fish skins, meat, rice, and

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other food scraps. Not all this organic material is good for compost, so it must be sorted. Organic materials, such as garden and food waste, can be used as basic materials for compost. Beesigamukama et al. (2018) used water hyacinth as a basic ingredient for compost. Dewilda et al. (2018) used a combination of market waste, yard waste and cow rumen as materials for making compost. Market waste, which is waste from slaughtering chickens, cows, goats and fish cleaning remains (scales, spines and innards), is unsuitable for compost.

In contrast to compost, which can use a variety of green (leaves) and brown (livestock manure) organic materials and food waste, the organic materials used to make eco-enzymes are limited. Only organic materials from vegetables and fruit can be used as basic ingredients for eco-enzymes (Benny et al., 2023; Ismail et al., 2023). If the ideal eco-enzyme basic material criteria are used, only around 1.6% (2 kg of 121.24 kg) of food waste can be processed into eco-enzyme. Based on the daily food waste data, we used yard, vegetable and fruit waste combinations as eco-enzyme materials in this research. Remaining organic material from food waste that cannot be used as compost or eco-enzyme material, such as fish skins, meat, and quite a lot of leftover fried food, still needs to be used. In their research, Zebua et al., (2023) proposed using food waste as substrate/maggot feed.

The Quality of Compost and Eco-Enzyme Product

The quality of compost made using a mixture of garden waste, food waste and goat manure after 60 days of composting is presented in Table 3. Compared with standards (SNI), the compost quality is poor because the material content and C: N ratio is too low, and the water content is too high. This low organic material content and C: N ratio may be attributed to the fact that at the beginning of composting, the organic material and N content were not initially determined, resulting in an incorrect C: N ratio. According to Rahman et al. (2020), the ideal C: N ratio of materials to produce good compost is 25:1–42:1. The addition of goat manure cannot improve the initial C: N ratio because at the end of composting, it increases N only at the largest ratio of goat manure, namely K3.

The high water content in the compost is probably due to the dominance of garden waste, which mainly consists of dry leaves that cannot absorb water effectively. As a result, the composting process may not proceed optimally. According to Rahman et al. (2020), it is necessary to incorporate garden waste (not limited to dry leaves) and measure the water content of the organic materials utilized in compost production. The water content of organic material intended for composting should be less than 50%. With

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an initial water content of organic material below 50%, the water content at the end of composting should not exceed 50%. Further selection is required to determine the ratio of composted materials to achieve optimal compost quality.

The addition of EM4 as a bioactivator, which is expected to accelerate composting, actually increased the water content in the resulting compost in this research. This result differs from several studies that demonstrate the effectiveness of EM4 in accelerating composting and increasing the nitrogen content of compost (Fauziyah et al., 2022; Pratiwi et al., 2023). However, Jassey et al. (2022) noted that the bioactivator's efficacy is inconsistent.

Table 3 ***Quality of compost produced***

Parameter	Standard	Treatments					
		K1E0	K2E0	K3E0	K1E1	K2E1	K3E1
Ash (%)	30-60 1)	5.51+0.32C	7.04+0.35BC	10.21+0.41A	6.18 +0.28BC	7.55 +0.26B	7.98 +0.21B
Nitrogen (%N)	>0.4 2)	2.06+0.18B	2.38+0.30B	2.75+0.02B	2.27+0.14B	2.56+0.08B	4.16+0.07A
Phosphate (%P2O5)	>0.1 2)	1.44+0.13D	2.23+0.25D	4.71+0.32C	6.24+0.32B	5.92+0.46B	8.72+1.07A
Potassium (%K2O)	>0.2 2)	0.79+0.23D	1.00+0.18DC	1.58+0.23C	4.65+0.75B	4.13+0.67B	8.45+0.5A
Organic materials (%)	9.8-32 2)	7.86+0.08C	8.52+0.96ABC	9.35+0.27A	8.23+0.32BC	8.82+0.27AB	8.8+0.2AB
Ratio (C: N)	10-20 2)	2.23+0.18A	2.08+0.17A	1.98+0.05A	2.12+0.31A	2.13+0.08A	1.69+0.04A
Water content (%)	<50 2)	75.98+1.81B	73.75+2.55B	66.37+3.13C	75.82+2.13B	76.33+1.73AB	79.11+0.67A

Note.

1)-2) = sources of Ogundare & Lajide (2013) and Badan Standarisasi Nasional (2023)

A-D = Means with different superscript letters indicate significant differences in the 5% DMRT test

K1, K2, and K3 were ratios of organic waste and goat manure of 3:1, 1:1, and 1:3, respectively

E1 and E0 were EM4 addition and without EM4 addition

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Unlike composting, where the criteria for selecting ideal materials to produce high-quality compost are well-established, the criteria for selecting ideal materials to produce eco-enzymes have not yet been determined. Based on research results using garden waste as material for making eco-enzymes, it is evident that eco-enzymes can also be produced. However, the quality of the eco-enzymes produced differs significantly when only food waste (vegetables and fruit) is used as the main ingredient for their production. The quality of eco-enzymes produced in this research is presented in Table 4.

Table 4 ***Quality of eco-enzyme produced***

Parameter		Treatments		
		E1	E2	E3
Nitrogen (%N)		0.45±0.1^{A}	0.42±0.09^{A}	0.42±0.07^{A}
Phosphate (%P_2O_5)		1.13±0.11^{C}	1.47±0.14^{B}	1.85±0.13^{A}
Potassium (%K_2O)		0.08±0.0^{C}	0.10±0.01^{B}	0.14±0.01^{A}
Organic materials (%)		12.20±5.4^{C}	25.05±3.61^{B}	33.72±3.88^{A}
Ratio (C: N)		16.20±6.48^{C}	36.44±10.93^{B}	48.21±9.03^{A}
Enzyme activity (U.mL^{-1})	Cellulase	23.10±3.19^{A}	14.32±1.34^{B}	15.79±3.23^{B}
	Amylase	13.83±3.4^{A}	3.80±0.38^{B}	3.21±0.39^{B}
	Urease	0.37±0.06^{B}	0.43±0.04^{A}	0.37±0.07^{B}

Note.

$^{A-C}$ = Means with different superscript letters indicate significant differences in the 5% DMRT test

E1–E3 = ratio of fruit/vegetable waste and yard waste of 1:0, 0:1, and 1:1, respectively

In terms of nitrogen (N), phosphorus (P), potassium (K) content, organic matter, and C: N ratio, Treatment 3 (E3), which utilized garden waste alone, exhibited the highest values. It is attributed to the similarity of its main ingredient to compost, albeit undergoing anaerobic fermentation. According to Rahman et al. (2020), the ideal compost material should include livestock manure to ensure sufficient nitrogen content for microbial needs during the degradation of compost material, which is predominantly comprised of plant material rich in carbon (C).

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However, if this eco-enzyme is used as liquid fertilizer, Treatment 1 (E1) is very suitable because the N content and C: N ratio are good (Benny et al., 2023). It is reinforced by the enzyme activity data in Treatment 1, which shows the highest value. According to Indraloka et al. (2023), a good eco-enzyme shows amylase enzyme activity and an acidic pH. In this research, not only amylase activity was detected, but cellulase and urease activities, which are important for soil fertility, were also detected.

Based on the analysis of the compost quality and eco-enzymes produced, it can be concluded that garden and food waste are most suitable for use as compost material. Meanwhile, only food waste of vegetables and fruit is suitable for producing good eco-enzymes.

Increasing the Economic Value of Waste by Transforming It Into Compost and Eco-Enzyme Products

House and garden waste will increase in economic value if converted into compost and eco-enzymes. The calculations are elaborated in Table 5. The first and second sections will detail the value-added calculation for compost and eco-enzymes. In contrast, the third section will explain the difference between the value-added from compost and eco-enzyme.

Section 1.

The processing margin, calculated as the output value minus the input price of raw materials, amounts to IDR2,142.86. Within this margin, labor income constitutes 83%, other inputs contribute 9%, and the entrepreneur's profit accounts for 7%. The average amount of added value obtained by transforming food and garden waste into compost is IDR1,942.86, resulting in an added value ratio of 65%, which exceeds the threshold of 50%, indicating a high level of value addition. The calculation of the added value obtained from processing food and garden waste into compost per kilogram closely aligns with the findings of Aga et al. (2018), which reported a value of IDR2,111. Turning food and garden waste into compost is widely practiced because it is not only easy but also because the resulting product can be sold, effectively transforming waste into a source of income (Tsai, 2020; Zakarya et al., 2021).

Section 2.

The processing margin obtained from the output value minus the input price of raw materials is IDR69,964 with a percentage of labor income of 41%, the contribution of other

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inputs is 5%, and the entrepreneur's profit is 54%. The average added value of transforming food waste to eco-enzyme is IDR66,327. Ninety-two, with an added value ratio of 94% (>50%), is considered high. In addition to providing a significant added value (94%), eco-enzymes offer various benefits, as evidenced by research studies (Natasya et al., 2023; Benny et al., 2023). One of these benefits includes serving as air fresheners (Muliarta et al., 2023).

Section 3.

The transformation of food waste to compost and eco-enzyme generates a high value-added ratio because the ratio is 65% and 94% higher than 50%. Further, eco-enzyme production contributes more to the entrepreneur's profit than compost production. It occurs because of the difference between the output values of each product. The compost value is IDR2,976.19, whereas the eco-enzyme value is IDR70,714,29. The high selling value of this eco-enzyme is attributed to its widespread usage, as people prefer to purchase it despite its lengthy manufacturing process.

Table 5 ***Added value of transforming food waste into compost and eco-enzyme***

I. Output, Input and Price		**Compost**	**Eco-enzyme**
1. Total Output/Product (Kg/Production Process)	A	250	16,5
2. Raw Material Input (Kg/Production Process)	B	168	7
3. Labor Input (HOK/Production Process)	C	4	4
4. Conversion Factor (Kg Output/Kg Raw Material)	D = A/B	1,5	2,4
5. Labor Coefficient (HOK/Kg Raw Material)	E = C/B	0,024	0,57
6. Output Price (IDR/Kg)	F	2.000	30.000
7. Labor Average Wages (IDR/Production Process)	G	75.000	50.000
II. Acceptance and Profits			

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8. Raw Material Input Prices (IDR/Kg)	H	833	750
9. Contribution of Other Inputs (IDR/Kg)	I	200	3.636,36
10. Output Value (IDR/Kg)	J = D x F	2.976,19	70.714,29
11. Value Added (IDR/Kg)	K = J – H – I	1.942,86	66.327,92
1) Value Added Ratio (%)	I% = K/J x 100%	65%	94%
12. Labor Income (Rp/Kg)	M = E x G	1.785,71	28.571,43
2) Labor Share (%)	N% = M/K x 100%	92%	43%
13. Profit (IDR/Kg)	O = K – M	157,143	37.756
3) Profit Rate (%)	P% = O/J x 100%	8%	57%
III. Reply to Owners of Factors of Production			
14. Margin (IDR/Kg)	Q = J – H	2.142,86	69.964,29
4) Labor Income (%)	R% = M/Q x 100%	83%	41%
5) Contribution of Other Inputs (%)	S% = I/Q x 100%	9%	5%
6) Entrepreneur Profit (%)	T% = O/Q x 100%	7%	54%

CONCLUSION

The compost produced falls into the poor category according to standards due to low material content, improper C: N ratio, and high water content. The initial mismanagement of organic material and nitrogen content likely contributed to these deficiencies. The dominance of garden waste and dehydrated leaves led to excessive water content, hindering optimal composting. Further research is needed to determine the ideal material ratios for optimal compost quality. Adding EM4 as a bioactivator unexpectedly increased water content. Compared to composting, criteria for selecting ideal materials for producing eco-enzymes still need to be determined. While eco-

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enzymes can be derived from garden waste, their quality varies significantly when food waste is the primary ingredient.

The processing margin and added value of transforming food and garden waste into compost and eco-enzymes demonstrate significant economic viability. Composting yields a processing margin of IDR2,142.86, with an added value ratio of 65%, while eco-enzyme production results in a margin of IDR69,964 and a ratio of 94%. Both processes generate high added value, with eco-enzymes offering additional benefits such as serving as air fresheners. Eco-enzyme production yields higher profits for entrepreneurs due to its higher output value, attributed to its widespread usage despite the longer manufacturing process.

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REFERENCES

Aga, F., Trisnanto, T.B., & Fitriani. (2018). *Analisis nilai tambah pengolahan sampah menjadi pupuk kompos di BUMDes P Yogyakarta* [*Analysis of the added value of processing waste into compost in BUMDes P Yogyakarta*]. [Student scientific work, Lampung State Polytechnic]. https://repository.polinela.ac.id/276/1/%5BJURNAL%5D%20Fidin%20Aga%20Laroibafih%2015751035.pdf

Arun, C., & Sivashanmugam, P. (2015). *Investigation of biocatalytic potential of garbage enzyme and its influence on stabilization of industrial waste activated sludge. Process Safety and Environmental Protection, 94, 471-478.*
https://doi.org/10.1016/j.psep.2014.10.008

Aulia, I.A.N., & Handayani, D. (2022). Keanekaragaman cendawan dari cairan Ecoenzyme dengan sumber bahan organik berbagai jenis kulit jeruk [Diversity of fungi from ecoenzyme liquid with organic material sourced from various types of orange peel]. Jurnal Serambi Biologi, 7(1), 114-119.
https://serambibiologi.ppj.unp.ac.id/index.php/srmb/article/view/47

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Badan Standarisasi Nasional. (2023). Spesifikasi kompos dari sampah organik domestic [Compost specification from domestic organic waste]. BSN. https://www.nawasis.org/portal/download/digilib/953-SNI-2004_7030_19.pdf

Beesigamukama, D., Katusabe, A.A., Tumuhairwe, J.B., Muoma, J., Maingi, J.M., Ombori, O., Nakanwagi, J., & Mukaminega, D. (2018). Agronomic effectiveness of water hyacinth-based composts. African Journal of Agricultural Research, 13(39), 2055-2062. https://doi.org/10.5897/AJAR2018.13440

Benny, N., Shams, R., Dash, K.K., Pandey, V.K., & Bashir, O. (2023). Recent trends in utilization of citrus fruits in production of eco-enzyme. Journal of Agriculture and Food Research, 13, 1-10. https://doi.org/10.1016/j.jafr.2023.100657

Bernfeld, P. (1955). Amylases, α and β. Methods in Enzymology, 1, *149-158. https://doi.org/10.1016/0076-6879(55)01021-5*

Dewilda, Y., Aziz, R., & Hasnureta. (2018). The effect of compost raw materials (market waste, yard waste, and cow rumen) to quality and quantity of compost. Indonesian Journal of Environmental Management and Sustainability, 3(1), 14-19. https://doi.org/10.26554/ijems.2019.3.4.14-19

Fauziyah, N.A., Nugraha, R.E., Wahyusi, K.N., Cahyo, M.S.K.P., & Iqbal, M. (2022, November 22). Variation of bio-activators (EM-4 and leri water) in processing household organic waste into organic compost ready to use in Gebang Putih Surabaya [Paper presentation]. Nusantara Science and Technology Proceedings, 3rd International Conference Eco-Innovation in Science, Engineering, and Technology. http://dx.doi.org/10.11594/nstp.2022.2710

Hayami, Y., Kawagoe, T., Morooka, Y., & Siregar, M. (1987). Agricultural marketing and processing in upland Java, a perspective from a Sunda Village. CGPRT Centre.

Hemalatha, M., & Visantini, P. (2020). Potential use of eco-enzyme for the treatment of metal based effluent. In IOP conference series: Materials science and engineering (Vol. 716, No. 1, p. 012016). IOP Publishing. https://iopscience.iop.org/article/10.1088/1757-899X/716/1/012016

Hendri, W., Sari, R.T., Har, E., Gusmaweti., Azrita., Deswati, L., Muhar, N., Yuselmi, R., Nuriadilla., & Khoirirafika. (2018). Pengolahan limbah organik dan anorganik sebagai transmode upaya peningkatan kreativitas masyarakat pantai Gondaria Pariaman [Proces-sing organic and inorganic waste as a transmode for increasing creativity in the

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Gondaria Pariaman coastal community]. Journal of Character Education Society, 1(2), 44-49. https://doi.org/10.31764/jces.v1i2.1638

Ibrahim, A., Fridayanti, A., & Delvia, F. (2015). Isolasi dan identifikasi Bakteri Asam Laktat (BAL) dari Buah Mangga (Mangifera indica L.) [Isolation and identification of Lactic Acid Bacteria (LAB) from mango fruit (Mangifera indica L.)]. Jurnal Ilmiah Manuntung, 1(2), 159-163. https://doi.org/10.51352/jim.v1i2.29

Indraloka, A.B., Istanti, A., & Utami, S.W. (2023). The physical and chemical characteristics of eco-enzyme fermentation liquid from several compositions of local fruits and vegetables in Banyuwangi. In IOP conference series: Earth and environmental science (Vol. 1168, No.1, p. 012018). IOP Publishing. https://iopscience.iop.org/article/10.1088/1755-1315/1168/1/012018

Ismail, A.Y., Adhya, I., Hendrayana, Y., Nurdin., Nurlaila, A., Herlina, N., Kosasih, D., Dzulfannazhir, F., Sofyan, H.N., & Aminudin, S. (2023). Analysis of eco-enzymes from organic waste based on fruits and vegetables. BIOMA: Jurnal Ilmiah Biologi, 12(2), 103-115. https://doi.org/10.26877/bioma.v12i2.17445

Istanti, A., & Utami, S.W. (2022). Utilization of household waste into eco-enzyme in Gitik Village, Rogojampi District, Banyuwangi. Warta Pengabdian, 16(1), 30-43. https://doi.org/10.19184/wrtp.v16i1.27328

Jakobsen, S.T. (1995). Aerobic decomposition of organic wastes 2. value of compost as a fertilizer. Resources, Conservation and Recycling, 13(1), 57-71. https://doi.org/10.1016/0921-3449(94)00015-W

Jassey, B., Syafrudin, Zaman, B., Ceesay, K., Touray, I., Ngum, J., & Prakoso, H. (2022). The effectiveness of EM4 and local micro-organisms (LOM) activators in organic waste processing in Brikama Market West Coast Region, The Gambia. In IOP conference series: Earth and environmental science (Vol. 1098, No. 1, p. 012010). IOP Publishing. https://doi.org/10.1088/1755-1315/1098/1/012010

Kandeler, E. & Gerber, H. (1988). Short-term assay of soil urease activity using colorimetric determination of ammonium. Biology and Fertility of Soils, 6(1), 68-72. https://doi.org/10.1007/BF00257924

Kementerian Lingkungan Hidup dan Kehutanan. (2023). Capaian kinerja pengelolaan sampah [Waste management performance achievements]. https://sipsn.menlhk.go.id/sipsn/

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Larasati, D., Astuti, A.P, & Maharani, E.T. (2020, November 25). Uji organoleptik eco-enzyme dari limbah kulit buah [Organoleptic test of eco-enzyme from fruit peel waste] [Paper presentation]. Seminar Nasional Edusainstek FMIPA UNIMUS 2020. https://prosiding.unimus.ac.id/index.php/edusaintek/article/view/569/572

Lokapirnasari, W.P., Setiawan, A., & Prawesthirini, S. (2015). Potensi kombinasi bakteri dan jamur selulolitik pada fermentasi bekatul terhadap kandungan serat kasar dan protein kasar [Potential combination of cellulolytic bacteria and fungi in rice bran fermentation on crude fiber and crude protein content]. Bulletin of Animal Science, 39(3), 174-179. https://doi.org/10.21059/buletinpeternak.v39i3.7985

Marliani, N. (2015). Pemanfaatan limbah rumah tangga (sampah anorganik) sebagai bentuk implementasi dari pendidikan lingkungan hidup [Utilization of household waste (inorganic waste) as a form of implementation of environmental education]. Formatif: Jurnal Ilmiah Pendidikan MIPA, 4(2), 124-132. http://dx.doi.org/10.30998/formatif.v4i2.146

Mustoyo, Simanjuntak, B.H., & Suprihati. (2013). Pengaruh dosis pupuk kandang terhadap stabilitas agregat tanah pada sistem pertanian organik [The effect of manure dosage on soil aggregate stability in organic farming systems]. AGRIC, 25(1), 51-57. https://doi.org/10.24246/agric.2013.v25.i1.p51-57

Muliarta, I.N., Sukmadewi, D.K.T., Pratama, G.A.S., Parawangsa, I.N.Y., & Setianingsih, N.L.P.P. (2023). Youth involvement in processing kitchen waste into eco-enzyme as air freshener in Sanur Kauh Village-Denpasar City. Asian Journal of Community Services (AJCS), 2(9), 759-776. https://doi.org/10.55927/ajcs.v2i9.6145

Natasya, N., Fadilah, M., Fitri, R., Farma, S.A., & Simwela, M. (2023). Analyzing the quality of eco-enzymes based on differences in plant tissue on the organic matter. Jurnal Biota, 9(1), 45-53. https://doi.org/10.19109/Biota.v9i1.13166

Novianti, A., & Muliarta, I.N. (2021). Eco-enzym based on household organic waste as multi purpose liquid. Agriwar Journal, 1(1), 12-17. https://doi.org/10.22225/aj.1.1.2021.12-17

Nur, T., Noor, A.R., & Elma, M. (2016). Pembuatan pupuk organik cair dari sampah organik rumah tangga dengan bioaktivator EM4 (effective microorganisms) [Making liquid organic fertilizer from household organic waste using EM4 (effective

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

miroorganisms) bioactivator]. Konversi, 5(2), 5-12. http://dx.doi.org/10.20527/k.v5i2.4766

Ogundare, M.O., & Lajide, L. (2013). Physico-chemical and mineral analysis of composts fortified with NPK fertilizer, ammonium chloride and kaolin. Journal of Agricultural Chemistry and Environment, 2(2), 27-33. http://dx.doi.org/10.4236/jacen.2013.22005

Pace, S.A., Yazdani, R., Kendall, A., Simmons, C.W., & VanderGheynst, J.S. (2018). Impact of organic waste composition on life cycle energy production, global warming and water use for treatment by anaerobic digestion followed by composting. Resources, Co nserva-tion and Recycling, 137, 126-135. https://doi.org/10.1016/j.resconrec.2018.05.030

Pajura, R. (2024). Composting municipal solid waste and animal manure in response to the current fertilizer crisis - a recent review. Science of The Total Environment, *912, 169-221. https://doi.org/10.1016/j.scitotenv.2023.169221*

Pratiwi, E.Y.P., Suhartini, & Sudrajat A.K. (2023). The effect of different bio-activators on compost quality of agricultural waste. Indonesian Journal of Bioscience (IJOBI), 1(1), 37-44. https://doi.org/10.21831/ijobi.v1i1.105

Rahman, M.H.A., Sadi, T., Ahmad, A.A., Masri, I.N., Yusoff, M.M., Kamaruddin, H., Shakri, N.A., Hamid, M.A.A., & Malek, R.A. (2020). Inventory and composting of yard waste in Serdang, Selangor, Malaysia. Heliyon, 6(8), 1-14. https://doi.org/10.1016/j.heliyon.2020.e04486

Robinson, D. (2024, January 3). 15 Biggest environmental problems of 2024. Earth.org. https://earth.org/the-biggest-environmental-problems-of-our-lifetime/

Rochyani, N., Utpalasari, R.L., & Dahliana, I. (2020). Analisis hasil konversi eco enzyme menggunakan nenas (Ananas comosus) dan pepaya (Carica papaya L.) [Anaysis of ecoenzyme conversion results using pineapple (Ananas comosus) and papaya (Carica papaya L.)]. Jurnal Redoks, 5(2), 135–140. https://doi.org/10.31851/redoks.v5i2.5060

Safdie, S. (2023, August 22). Global Food Waste in 2024. Greenly.institue. https://greenly.earth/en-us/blog/ecology-news/global-food-waste-in-2022

Sayara, T., Salimia, R.B., Hawamde, F., & Sánchez, A. (2020). Review Recycling of Organic Wastes through Composting: Process Performance and Compost Application in Agriculture. Agronomy, 10(11), 1-23. https://doi.org/10.3390/agronomy10111838

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Srinivasrao, C., Grover, M., Kundu, S., & Desai, S. (2017). Soil enzymes. In Rattan L. (Eds), Encyclopedia of soil science (pp. 2100-2107). CRC Press.
https://www.researchgate.net/publication/314213236_Soil_Enzymes

Sholihah, S.M., Banu, L.S., Nuraini, A., & Piguno, P.A. (2020). Kajian perbandingan analisa usaha tani serta produktivitas tanaman cabai rawit di dalam polibag dan di lahan pekarangan [Comparative study of farming business analysis and productivity of cayenne pepper plants in polybags and in the yard]. Jurnal Ilmiah Respati, 11(1), 13-23. https://doi.org/10.52643/jir.v11i1.844

Tsai, W.T. (2020). Turning food waste into value-added resources: current status and regulatory promotion in Taiwan. Resources, 9(5), 1-11. https://doi.org/10.3390/resources9050053

Verma, D., Singh, A.N., & Shukla, A.K. (2019, July 14). Use of garbage enzyme for treatment of waste water [Paper presentation]. 2nd International Conference on Latest Advancements & Future Trends in Engineering, Science & Management. http://proceeding.conferenceworld.in/OUCIP_14_JULY/31oJuToaUFJWmo936.pdf

Zakarya, I.A., Izhar, T.N.T., Noordin, N.M., Ibrahim, N., & Kamaruddin, S.A. (2021). Rapid composting of food waste and yard waste with effective microorganisms (EM). CENVIRON 2021. In IOP Conference series: Earth and environmental science (Vol. 920, No. 1, p. 012028). IOP Publishing.
https://doi.org/10.1088/1755-1315/920/1/012028

Zebua, D.D.N., Meitiniarti, V.I., & Simamora, L. (2023). Efficient solutions for food waste in Salatiga City. In IOP Conference series: Earth and environmental science (Vol. 1275, No. 1, p. 012036). IOP Publishing. ***https://doi.org****/10.1088/1755-1315/1275/1/012036*

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