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Availability And Utilization of Organic Waste: A Study on the Potential of Sugarcane Bagasse and Tofu Waste as Raw Materials for Liquid Organic Fertilizer

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ABSTRACT: Organic waste is abundantly available, yet its utilization remains suboptimal. Among the various types of organic waste, sugarcane bagasse and tofu waste are notable for their high content of essential nutrients that can support plant growth and development. These materials can be processed into liquid organic fertilizer with the addition of supplementary inputs to enhance the availability of nutrients required by plants.

This study utilized sugarcane bagasse and tofu waste as primary raw materials, with cow feces serving as a supplementary component. The research was conducted in Sidoarjo, East Java, Indonesia, and applied two experimental factors: B, representing the type of base material (sugarcane bagasse (B1) and tofu waste (B2)), and R, representing the ratio between the base material and the supplement (1:5 (R1); 1:5 (R2); and 1:7.5 (R3)). A total of six treatment combinations were examined.

Parameters observed during the study included temperature, pH, organic carbon (C-organic), ammonium, nitrate, and phosphate content, measured from the second to the eighth week of the fermentation process. The temperature during the production of the liquid organic fertilizer ranged from 28°C to 30°C. The resulting pH levels were generally acidic, ranging from 3.5 to 5.0. The highest C-organic content was observed in treatments using tofu waste as the base material. Conversely, treatments using sugarcane bagasse as the base material yielded higher concentrations of ammonium, nitrate, and phosphate.

KEYWORDS: Fertilizer, Organic Fertilizer, Liquid Fertilizer, Surgance Baggase, Tofu Waste

I. INTRODUCTION

Fertilizer is a material that plays a crucial role in supporting the growth and development of plants. Based on their composition, fertilizers are generally classified into two categories: organic and inorganic. Organic fertilizers are derived from the processing of organic waste such as plant residues, animal manure, and animal bones, which contain essential minerals that enhance soil fertility (Rithania et al., 2021).

Sugarcane (Saccharum officinarum) is a crop primarily used in the production of granulated sugar. The sugar production process generates solid waste in the form of fibrous residues known as bagasse. Sugarcane bagasse is a byproduct of the juice extraction process (Rini et al., 2016). Bagasse contains approximately 3.3% residual sugar, which can be converted into carbohydrates—an essential nutrient for plants. This indicates the potential of sugarcane bagasse as a raw material for organic fertilizer production (Suryati, 2014).

Tofu is a processed soybean product that generates waste in the form of fine solids known as tofu dregs. Chemically, tofu dregs contain both macro and micronutrients, including Nitrogen (N), Phosphorus (P), Potassium (K), Iron (Fe) 200–500 ppm, Manganese (Mn) 30–100 ppm, Copper (Cu) 5–15 ppm, Cobalt (Co) < 1 ppm, and Zinc (Zn) > 50 ppm. Tofu waste is also rich in N, P, K, Calcium (Ca), Magnesium (Mg), and organic carbon (C), all of which contribute to improving soil and plant fertility (Nurhayati, 2021).

Based on the above description, it is evident that both sugarcane bagasse and tofu waste possess high nutrient content and therefore hold strong potential as organic fertilizer materials. However, research exploring their use in this context remains limited. In light of this, the present study aims to investigate this issue through a research project entitled: "Study and Identification of the Potential of Sugarcane Bagasse and Tofu Waste as Raw Materials for Liquid Organic Fertilizer.

II. RESEARCH METHODS

A. *Study Area*

The study titled "Study and Identification of the Potential of Sugarcane Bagasse and Tofu Waste as Raw Materials for Organic Fertilizer" was conducted in Jati Village, Sidoarjo District, East Java, and in the Laboratory of the Faculty of Agriculture, Universitas Pembangunan Nasional (UPN) "Veteran" East Java, from April to October 2023.

B. *Research Metodology*

This research employed a Completely Randomized Design (CRD) with a factorial arrangement. Three factors were tested in the study: type of material, composition ratio, and type of fertilizer. Factor 1 (B): Type of material, consisting of two levels = B1 = sugarcane bagasse ; B2 = tofu waste. Factor 2 (R): Ratio of base material to cow manure, consisting of three levels = R1 = 1:2.5 ; R2 = 1:5 ; R3 = 1:7.5 This factorial design resulted in six treatment combinations.

C. Research Parameter

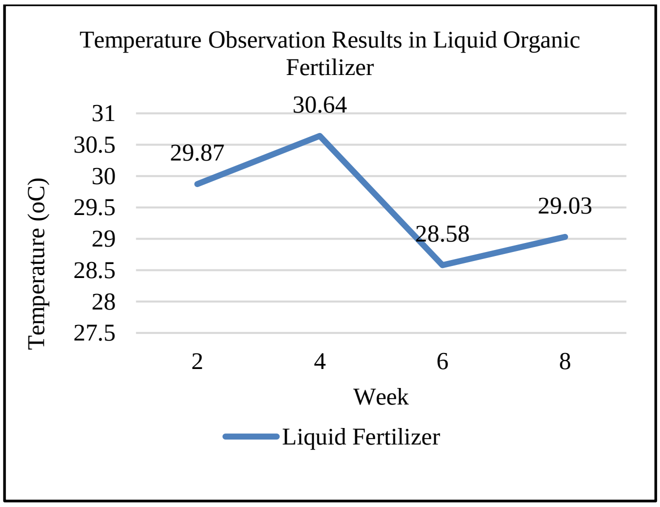
The following parameters were observed and analyzed in this study: Temperature, Acidity level (pH), Organic carbon content (C-organic), Nitrogen content (in the form of Ammonium and Nitrate), and Phosphate (P) content.

Samples were collected every two weeks, starting from the second week up to the eighth week of the organic fertilizer production process.

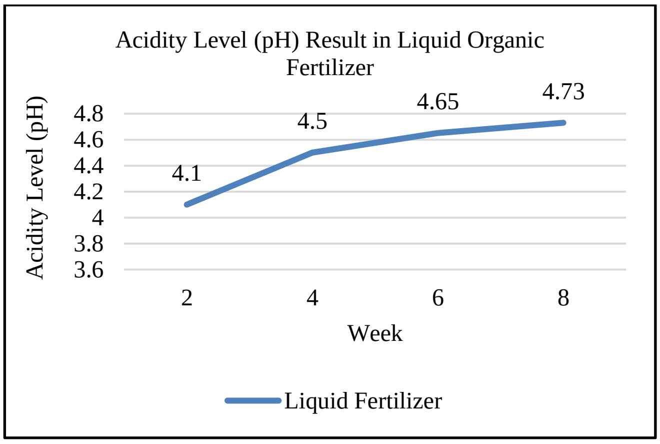
D. Data Analysis

Data analysis was carried out by collecting both primary and secondary data, followed by data tabulation. Pre-treatment data included: Moisture content test, Physical analysis, and Chemical analysis. Post-treatment data included repeated physical, chemical, and microbial tests. The observational data were statistically analyzed using Analysis of Variance (ANOVA) to identify interactions between treatments. If significant differences were found, further testing was conducted using the Least Significant Difference (LSD) test at the 5% significance level.

II. HASIL ANALISIS



The temperature observations of the liquid organic fertilizer showed a decline in the final week of monitoring. This decrease likely occurred because the fermentation process had ceased within the organic fertilizer mixture, leading to a drop in temperature and a tendency toward stabilization. Additionally, during the earlier stages of liquid organic fertilizer production, microbial activity was likely more intense due to better oxygen availability, which contributed to higher temperatures (Fitri, 2021).



The results from the above graph indicate that the liquid organic fertilizer tends to be acidic, as shown by its pH values ranging between 3.5 and 5.0. This acidity is likely due to the presence of liquid components used to dissolve the cow manure. The liquid organic fertilizer fermentation process is typically closed and intensive, which facilitates the production of organic acids that contribute to the decrease in pH levels. Additionally, the moisture content in the liquid organic fertilizer may also influence the reduction in pH (Fitri, 2021).

C-Organic Result in Liquid Organic Fertilizer

Treatment	**C-Organic (%) Week**							
	2		**4**		**6**		**8**	
B1R1	3,61	b	4,32	b	4,74	d	5,57	b
B1R2	3,88	c	4,49	c	4,25	c	5,59	bc
B1R3	2,33	a	2,16	a	1,76	a	1,70	a
B2R1	5,60	e	6,17	d	7,74	f	6,47	c
B2R2	6,86	f	6,76	e	3,17	b	6,93	d
B2R3	5,46	d	7,02	f	6,83	e	6,99	de
BNT	**0,183**		**0,170**		**0,182**		**0,288**	

The results of the C-organic content test, as shown in the table above, indicate that in the second week, the highest value was observed in the B2R2 combination (liquid organic fertilizer made from tofu waste at a 1:5 ratio). In the fourth and eighth weeks, the highest values were found in the B2R3 combination (tofu waste at a 1:7.5 ratio), while in the sixth week, the highest value was recorded in the B2R1 combination (tofu waste at a 1:2.5 ratio). These results suggest that the combinations with tofu waste as the base material frequently yielded the highest C-organic content. According to Auliana (2013), tofu waste, derived from soybeans, is a rich source of organic carbon in the form of carbohydrates, as well as proteins and fats.

Amonium Result in Liquid Organic Fertilizer

Treatment	NH_4^+ (%) Week- 2	4	6	8
B1R1	0,034 b	0,033 bc	0,011 a	0,008 a
B1R2	0,030 ab	0,015 a	0,050 c	0,012 ab
B1R3	0,027 a	0,026 b	0,041 b	0,018 ab
B2R1	0,036 bc	0,057 c	0,071 d	0,077 b
B2R2	0,071 d	0,092 e	0,092 f	0,087 bc
B2R3	0,052 c	0,084 d	0,082 e	0,135 c
BNT	**0,005**	**0,009**	**0,009**	**0,013**

The results of the ammonium analysis, as shown in the table above, indicate that the highest values from the second to the sixth week were found in the B2R2 combination (liquid organic fertilizer made from tofu waste at a 1:5 ratio). In the eighth week, the highest value was observed in the B2R3 combination (tofu waste at a 1:7.5 ratio).

Nitrate Result in Liquid Organic Fertilizer

Treatment	NO_3^- (%) Week- 2	4	6	8
B1R1	0,025 b	0,017 b	0,008 a	0,008 a
B1R2	0,004 a	0,012 ab	0,013 ab	0,010 ab
B1R3	0,010 ab	0,011 a	0,023 b	0,016 b
B2R1	0,007 ab	0,019 bc	0,017 ab	0,013 ab
B2R2	0,009 ab	0,011 a	0,029 bc	0,011 ab
B2R3	0,037 bc	0,023 c	0,011 ab	0,031 c
BNT	**0,012**	**0,006**	**0,013**	**0,008**

The results of the ammonium analysis, as shown in the table above, indicate that the highest values in weeks two, four, and eight were observed in the B2R3 combination (liquid organic fertilizer made from tofu waste at a 1:7.5 ratio). In week six, the highest value was found in the B2R2 combination (tofu waste at a 1:5 ratio).

The results of both ammonium and nitrate analyses consistently showed that the highest values appeared in combinations using tofu waste from the second to the eighth week. This may be attributed to the higher protein content in tofu waste compared to sugarcane bagasse. According to Rukmayanti (2019), the protein content in tofu waste contributes to higher nitrogen (N) levels, as proteins are broken down into amino acids, which are subsequently converted into nitrate.

Fosfat Result in Liquid Organic Fertilizer

Treatment	P_2O_5 (%) Week- 2	4	6	8
B1R1	4,00 d	3,90 c	5,39 d	6,04 d
B1R2	3,83 cd	4,28 d	5,69 e	6,51 e
B1R3	3,82 c	4,29 de	6,32 f	6,65 ef
B2R1	3,53 b	3,95 cd	4,96 c	5,36 c
B2R2	3,54 bc	3,56 b	4,11 b	4,49 b
B2R3	3,13 a	3,28 a	3,82 a	4,14 a
BNT	**0,087**	**0,111**	**0,086**	**0,166**

The phosphate analysis results of the liquid organic fertilizer are presented in the table above. The highest phosphate content in each observation week was consistently found in the B1R3 combination (liquid organic fertilizer made from sugarcane bagasse at a 1:7.5 ratio). As discussed in the section on phosphate content in solid organic fertilizer, the phosphate absorption and content in sugarcane bagasse are higher than those in tofu waste. The highest ratio (1:7.5) likely resulted in greater microbial availability within the organic fertilizer. A larger proportion of cow feces supports the proliferation of microorganisms essential for the fermentation process.

During the early stages of fermentation, the phosphate (P) content tends to be low because microorganisms are still adapting—particularly phosphate-solubilizing microbes that produce phosphatase enzymes responsible for mineralization. Once these phosphate-solubilizing bacteria enter the exponential growth phase, they begin producing phosphatase enzymes that help dissolve phosphate in the substrate and break down bound phosphates, thereby increasing the available P content (Rukmayanti, 2019).

CONCLUSIONS

Based on the processed data and discussions above, the following conclusions can be drawn:

- Tofu waste as a raw material contains higher levels of C-organic and Nitrogen compared to sugarcane bagasse. However, in terms of Phosphorus availability, sugarcane bagasse is more effective than tofu waste.
- Liquid organic fertilizer made from tofu waste contains significant levels of C-organic and Nitrogen, including both ammonium and nitrate.

Meanwhile, liquid organic fertilizer made from sugarcane bagasse shows higher phosphate content.

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