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The Influence of Raw Materials on Quality of Cattle Farm Waste Liquid Organic Fertilizer in Tuban Regency

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ABSTRACT

Urine is a liquid waste of cattle farming that can be used as raw material for producing liquid organic fertilizer. This study aims to determine the effect of the process of obtaining urine waste in cattle farms on the quality of liquid organic fertilizer. The measured parameters include N, P, K, pH, organic-C, and bacterial contamination, in accordance with the Indonesian Ministry of Agriculture Regulation No. 261 of 2019. The method used in this research is fermentation with EM4 decomposer for 30 days. The results of the one-way ANOVA test showed significant differences in pH, organic-C, N, P, and K between B1 and B2, with higher values of pH, organic-C, N, and P in liquid organic fertilizer made from cattle urine mixed with manure. Meanwhile, the K value was higher in liquid organic fertilizer made from pure urine without manure.

A. INTRODUCTION

Tuban Regency is one of the largest corn-producing regions in East Java. According to data from the Central Statistics Agency (BPS) of Tuban Regency, corn production in 2022 reached 774,322 tons with a planting area of 137,121 hectares. This intensive corn production increases the demand for fertilizers as the primary source of macronutrients, especially Nitrogen (N). Currently, most farmers in Tuban Regency use inorganic fertilizers such as urea for the main nitrogen source for corn. However, continuous use of inorganic fertilizers can damage agricultural land by altering its physical, chemical, and biological properties. Unaddressed soil degradation can lead to a decline in crop yield quality and quantity (Amanda et al., 2023; Fadillah et al., 2022; Mansyur et al., 2021).

Further studies have identified various types of nitrogen-rich fertilizers that can be used as alternatives to inorganic fertilizers, such as bio-urine liquid organic fertilizer. This type of fertilizer is made from livestock urine, such as cattle, goats, sheep, buffalo, etc. The raw materials vary in composition, affecting the quality of the liquid organic fertilizer (Lussy et al., 2017; Mashudi et al., 2023; Subekti et al., 2022).

Organic fertilizer may not give an affected simultaneously on the yield crop production. Some previous study show that organic fertilizer is a slowrelease nutrient on the plant. So, it does not boot the nutrient immediately on the single growing season. But, in long way term yield will improve significally because of the soil health improvement from microbial activity and structure(Knapp et al., 2023; Martinez et al., 2016). in another study, the synergistic effect of combining different combination raw material of organic fertilizer will improve the nutritional quality of the vegetable such as Vitamin C on Chinesse Cabbage and asparagus lettuce (Liu et al., 2025). It has been reported on another study that different organic fertilizer used affected on the quality of soybean cultivation (Gunawan et al., 2025). This result suggesting a potential way to make the best quality of organic fertilizer from different organic raw material. Based on previous research of this study (Nurfitria & Febriyantiningrum, 2022), Tuban Regency has significant potential for utilizing dairy cattle waste as raw material for bio-urine liquid organic fertilizer. Data from BPS Tuban recorded 344,253 cattle, producing approximately 1,277,012 liters of urine daily. Currently, this urine waste is underutilized. Cattle urine is highly beneficial as a raw material for liquid organic fertilizer due to its high N and K content (Alam et al., 2022; Anderson, 2023; Darmawan, 2023; Lalla et al., 2024; Vebriyanti et al., 2022a).

This article discusses the quality of the produced liquid organic fertilizer from dairy cattle liquid waste (urine) in Tuban Regency. The novelty of this study to prove that different raw material of cattle farm waste especially the urine and feces give an effect on the quality of produced liquid organic fertilizer. Previous study from (Ana et al., 2026) show that the organic fertilizer from cow urine in Magelang regency give the best quality with Nitrogen (N) 1,37 ± 0,015 %, Phospor (P) 18 ± 0,002 % and Kalium (K) 0,55 ± 0,018 %. In Wonogiri regency, liquid organic fertilizer from cow urine contains N 2.67%, P 1.34% and K 1.86% (Mujiyo et al., 2023). So, the objective of this study is to knowing the effect of different raw material from cattle farm waste from Tuban regency on the quality of liquid organic fertilizer. To gain the objective of this study, variable is the influence of the cow urine purity and combination formula on the quality of liquid organic fertilizer. The raw materials compared are pure urine (B1) and urine mixed with solid waste (feces) (B2). The quality of the bio-urine is evaluated based on parameters set by the Indonesian Ministry of Agriculture Regulation No. 261 of 2019, including Nitrogen (N), Phospor (P), Kalium (K), pH, organic-C, and bacterial contamination. This parameter will be used as an initial indicator of the quality of the liquid organic fertilizer before being applied to plants.

B. METHODS

This study is pure experimental research designed to examine the effect of raw material treatment on the quality of liquid organic fertilizer. The materials used include cattle urine collected directly (B1) and urine from manure storage mixed with solid waste (B2). Another material that used in this reseach is EM4 decomposer, and some spices to reduce odor during fermentation (Purwasih & Mukminah, 2022). The used tool are compost drums, stirrers, and measuring cup.

The Manufacture of Liquid Organic Fertilizer

The stages carried out in this research are the manufacture of liquid organic fertilizer biourine and then testing its quality. Liquid organic fertilizer processing step is :

1. Preparing a closed container.
2. Adding 1000 ml of B1 and B2 urine (with two repetitions).
3. Adding EM4 decomposer.
4. Incorporating molasses and spices.
5. Sealing the container and stirring weekly.
6. Fermenting for 30 days.

Characterization of Liquid Organic Fertilizer

The fertilizer was tested for N, P, K, pH, organic-C, and bacterial contamination (*E. coli* and *Salmonella* sp.) in accordance with the Indonesian Ministry of Agriculture Regulation No. 261 of 2019. Chemical analysis was conducted at the Chemistry Laboratory of Universitas Muhammadiyah Malang, while bacterial contamination tests were performed at the Animal Health Laboratory of the Tuban Regency Livestock Office.

Data Analysis

The characterization results were statistically analyzed using a one-way ANOVA test to determine the significant differences between B1 and B2 as a raw material on the quality of liquid organic fertilizer.

C. RESULT AND DISCUSSION

1. Liquid Organic Fertilizer Characteristic

The observed characteristics included organoleptic properties (color and odor) and temperature (table 1).

Table 1. characteristic of Liquid Organic Fertilizer

No.	Characteristic	B1	B2
1.	Organoleptic (Colour)	Dark Brown-Black	Dark Brown-Black
2.	Organoleptic (Odor)	Typical smell of fermented fertilizer	Typical smell of fermented fertilizer, but a slight smell of cow dung
3.	Temperature	28° C	28° C

The characteristics of liquid organic fertilizer were observed to determine the level of maturity during the fermentation process. The first parameter was the smell of the liquid organic fertilizer. The results showed that variation B1 had a distinctive organic fertilizer smell, similar to soil, while variation B2 had the same smell but with a slight odor of raw materials, specifically cow dung. The presence of raw material odor at the end of fermentation indicates that the organic fertilizer has not fully matured. However, the absence of foul odors suggests no harmful compounds were present, which could be detrimental to plants. Therefore, chemical and biological parameter tests are essential to confirm the success of the liquid organic fertilizer production in this study.

Color serves as another indicator of fertilizer maturity. A blackish-brown color signifies that the fertilizer is mature and ready for application to plants. The results revealed that both variations, B1 and B2, exhibited a dark brown to black color, confirming successful fermentation. The initial raw materials were clear light yellow for B1 and slightly cloudy light yellow for B2, with the color change indicating the progression of fermentation by decomposers. The observed temperature of 34°C (room temperature) further supported the maturity of the fertilizer, as temperatures typically rise during fermentation and return to room levels upon completion.

Quality of Biourin Liquid Organic Fertilizer

The quality of liquid organic fertilizer had seen on several parameter as describe before. Kualtias pupuk organik cair biourin dilihat dari beberapa oaramter yang telah diujikan. Oneway Onova test also been carried out on each parameter and the result show that all quality paramater are significally different.

Table 2. Quality analisis of Liquid Organic Fertilizer

Parameter	Variation		Quality Standar
	B1	B2	
pH	5,68 ± 0,01[a]	6,17 ± 0,03[b]	4-9
C-Organic (%)	11,58 ± 0,42 [a]	17,42 ± 0,42 [b]	Minimum 10
N (%)	4,87 ± 0,035 [a]	6,58 ± 0,14 [b]	Total N + P + K = 2-6
P (%)	0,28 ± 0,0015 [a]	0,80 ± 0,0015 [b]	
K (%)	0,35 ± 0,001 [a]	0,25 ± 0,001[b]	
***E. coli* contamination (cfu/mL)**	Negative	Negative	< 1 x 10^2
***Salmonella* sp. contamination (cfu/mL)**	Negative	Negative	< 1 x 10^2

Description: Data is the mean of the replication ± standard deviation

[a-b] different superscripts in the same coloumn indicate the significant different (P<0,05)

DISCUSSION

pH level

pH (Power of Hydrogen) measures the acidity or alkalinity of a substance on a scale of 1–14, where values below 7 indicate acidity, 7 is neutral, and above 7 is alkaline. As a critical parameter for liquid organic fertilizer quality, an optimal pH range enhances plant growth by maximizing nutrient absorption from the soil (Fiddaroini et al., 2023).

In line with the Indonesian Ministry of Agriculture Regulation No. 261 of 2019, the permissible pH range for liquid organic fertilizer is 4–9. This study found that both variations, B1 (pure urine) and B2 (urine mixed with manure), exhibited pH values within this standard. Statistical analysis (ANOVA) revealed that the difference in raw materials did not significantly affect the pH of the fertilizer. However, the slightly lower pH in B2 may be attributed to the presence of cow manure, which contains organic fibers like cellulose from cattle feed (Afsahi et al., 2020). During fermentation, these fibers decompose into organic acids, marginally reducing pH. Further breakdown of these acids into simpler compounds (e.g., ammonia and carbon dioxide) requires extended time and microbial activity, suggesting the need for additional research to explore these dynamics in liquid organic fertilizer production.

C-Organic Content

C-Organic is the main constituent element of organic matter derived from plant residues, animal manure, or other microorganism. C-Organic content can be used as an indikator of the sucess in the producing liquid organic fertilizer in this study. C-Organic plays a vital role in plant growth by enhancing soil fertility and ensuring nutrient availability. Adequate C-Organic levels improve soil properties through increased aggregation, better aeration, and improved water retention. Balanced C-Organic content also stabilizes the decomposition of organic matter, preventing nitrogen immobilization that could reduce nutrient availability for plants.

The results of this study indicate that the C-Organic content of the fertilizers complied with the quality standards of the Indonesian Ministry of Agriculture Regulation No. 216 of 2019. Variation B1 (pure urine) exhibited lower C-Organic content compared to B2 (urine mixed with manure). This difference is attributed to the decomposition of organic matter into organic acids, which lowers pH (Kamaliyah & Wahyuni, 2023). The C-Organic values of the fertilizers were proportional to the nitrogen content, ensuring optimal decomposition without nitrogen immobilization. Statistical analysis (one-way ANOVA) confirmed that the raw materials significantly influenced the C-Organic content, with B2 showing higher levels due to the presence of carbon-rich components like cellulose and lignin in cow manure.

Macronutrient Content

The nitrogen (N) content in the liquid fertilizers varied significantly between treatments. Both B1 and B2 met the standards of the Indonesian Ministry of Agriculture Regulation No. 261 of 2019, which specifies a minimum N-Organic content of 0.5% and total N content of 2–6%. The higher nitrogen content in B2 is likely due to the inclusion of cow manure, which provides additional organic matter for microbial decomposition. (Vebriyanti et al., 2022b). Nitrogen is the result of fermentation carried out by microorganism, in this study is EM4. The more substances that can be decomposed by microorganism, the higher nitrogen level will be produced. The decomposition of organic matter into nitrogen can also influenced by the fermentation time length. This topic will be used as further research.

Phospor (P) is one of the element in the liquid organic fertilizer. It has an important role in plant root growth, ATP energy formulation, flowering, and fertilization. The amount of P in cow dung tends to be more Phospor (P) levels in the liquid organic fertilizer produced are signifivally different for the use of raw material B1 and B2. P levels with B2 feedstock were higher than B1. The reason supporting this result is that cows excrete P throth feces with the main source of P is coming from the remaining grains in the feed. As for P in urine, it is found in the form of phosphate ions (PO_4^{3-}) in very small amount (Wirne, 2022).

Potassium (K) is the nutrient that is required to be contained in liquid organic fertilizer. This element plays a role for plants in maintaining leaf color and stem height. The use of raw materials B1 and B2 makes the K content in liquid organic fertilizer significantly different. Liquid organic fertilizer made using raw materials B1 has a higher K content because K is excreted through the kidneys in the form of urine (Alam et al., 2022).

Contamination of *E.coli* and *Salmonella sp.*

Liquid organic fertilizer can be applied directly to plants by spraying on plant parts or directly into the soil. Direct application to plants makes microbial contaminant parameters can be used to determine the quality of liquid organic fertilizer. Based on Kepmentan No. 216 of 2019, microbial contaminants that must be considered are *E. Coli* and *Salmonella* sp. With a quality standard value of < 1 x 10^2. These two microbes are included in the quality parameters of liquid organic fertilizer because they can disturb and endanger humans if consumed from contaminated plants. (Madyaningrana et al., 2022) . Liquid organic fertilizer can be applied directly to plants by spraying on plant parts or directly into the soil. In addition, the presence of these microbes can also interfere with the decomposition process of organic matter by decomposer bacteria during the fermentation process. The results obtained in this study show that variations B1 and B2 are in accordance with quality standards because they do not contain microbial contaminants *E. Coli* and *Salmonella sp.*

D. CONCLUSION AND SUGGESTIONS

The conclusion that can be drawn in this study is that the use of raw materials B1 (cow urine) and B2 (cow urine + cow dung) produces liquid organic fertilizer that meets the quality standards according to Kepmentan no 219 of 2019. The quality parameters, namely pH, C-Organic, N, P and K differ significantly between B1 and B2 with the value of liquid organic fertilizer made from cow urine mixed with cow dung having higher pH, C-Organic, N, P values. Meanwhile, the K parameter is higher for liquid organic fertilizer made from pure urine without mixing cow dung. Future study should focus on the combination of B1/B2 fertilizers according to the plant growth phase especially on corn.

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