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Physico-Chemical Characterization of Liquid Organic Fertilizer from Urban Organic Waste

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This study aims to provide information about various types of urban organic waste used as raw material for liquid organic fertilizer, to collect data on the nutritional content of liquid organic fertilizer derived from various types of urban organic waste, and to recommend types of urban organic waste potential to be developed as raw material for fertilizers produced by the community. To make liquid organic fertilizer, a research project with six raw materials: vegetable waste (limited to familiar Cruciferae), fruit waste (limited to bananas and papayas), sprout waste, food waste, catfish waste, and cow blood waste. The organic matter, N, P, K, C-organic, Mg, Ca, Cu, Zn, Fe, and humic acid content of ready-made liquid fertilizer were examined across a diverse range of experimental variables. The material's structure, color, smell, temperature, and pH change during the production of liquid organic fertilizer. Liquid fertilizer from urban organic waste contains complete nutrients, including organic matter 17.98-22.15%, N 0.03-0.08%, P 0.04-0.095, K 0.31-0.825, C-organic 0.79-1.22%, Mg 2.26-4.12 ppm, Ca 2.26-11.80 ppm, Cu 0.52-0.86 ppm, Zn 2.83-3.83 ppm, Fe 2.83-3.81 ppm, and humic acid 3.85-7. POC made from fish and animal blood waste has a higher nutrient content than POC from plant waste, but it also produces odor during production, making people uninterested. Thus, it is suggested that the next research is to discover a method for producing odorless POC from fish waste and animal blood.

1. Introduction

Market, household, and leaf wastes are examples of urban waste that can be processed into organic fertilizer (Aseffa et al., 2019; Ajaweed et al., 2022). Untreated urban waste disposed of in the open will cause environmental and health problems (Jara-Samaniego et al., 2017). Sustainable waste management will increase the usability of waste in urban agriculture to produce food (Tawiyah et al., 2020; Schröder et al., 2021; Sharma and Agarwal., 2019).Organic fertilizers improve soil fertility and biodiversity while leaving no residues on plants, making them safe for the environment and human health (Lesik et al., 2019; Wongsaroj et al., 2021; Aseffa et al., 2019). Organic fertilizers can improve ecosystem resilience by increasing organic matter, plant nutrients, and aggregate stability leading to improved soil structure, water transport, and water holding capacity (Van der Wurff et al., 2016). Using chemical fertilizers at a 50% rate in conjunction with organic fertilizers can increase crop yields and improve soil nutrient availability (Nguyen., 2018; Abera et al., 2018).Urban organic waste has the potential to provide compost for urban agriculture development. People in urban areas can compost a mixture of tree stumps, household waste, and market waste (Haryanta et al., 2017), and the compost can be used in urban farming (Haryanta et al., 2019; Haryanta et al., 2021). Liquid organic fertilizer from biological waste contains more nutrients, making it ideal for boosting plant growth and vitality. Liquid organic fertilizer with many plant nutrients is environmentally friendly and well-suited to the growth of urban agriculture (Ahmad Sanadi et al., 2019). The abundant fish and fruit waste as byproducts of fish processing and post-harvest fruit handling can be made into liquid organic fertilizer (Ranasinghe et al., 2019). A liquid organic fertilizer containing macronutrients (P, K) and micronutrients (Fe, Zn, Mn, Cu, and B) made from plant residues and animal manure is a potential multi-nutrient fertilizer (Martnez-Alcántara et al., 2016). Urban organic waste is a source of environmental pollution and public health problems. One solution that can be done is to process it into liquid organic fertilizer as a source of plant nutrition. The research aims to provide data that various types of urban organic waste can be used as raw materials for liquid organic fertilizers, to characterize its nutrients taken from

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various types of urban organic waste, and recommend types of urban organic waste that have the potential to be developed as raw materials for organic fertilizers by society.

2. Materials and Methods

2.1 Preparation of raw materials

Vegetable, fruit, sprout, and fish waste were from markets in the Surabaya area, food waste from wedding reception catering, and cow blood waste from the Surabaya City Slaughterhouse (RPH).

2.2 Experimental Design

Examine the use of six raw materials for the production of liquid organic fertilizer: (1) a mixture of six wastes, (2) vegetable waste, (3) fruit waste, (4) sprouts waste, (5) food waste, (6) catfish waste, and (7) cow blood waste. The volume of liquid organic fertilizer produced from each raw material is 20-25 l. While producing liquid organic fertilizer, the material changes were directly observed in each unit. The nutrient content of each raw material type was calculated by collecting 100 cc of liquid organic fertilizer samples.

2.3 Making Liquid Organic Fertilizer

The process can be seen in the following stages:

- Activate the starter microbes by combining 500 cc of EM4 liquid, 500 grams of sugar, and water in a jerry can and incubating it for 3-5 days.
- Prepare the following equipment for the production of liquid organic fertilizer: (1) 30 l drums with covers perforated as large as a small hose (1 cm diameter), (2) 1.5 l plastic bottles with covers perforated as large as a small hose (1 cm diameter).
- Depending on the type of material, prepare up to 5-8 kg of raw materials, then cut or blend to make it as smooth as possible.
- Mix the ingredients in the drum: (1) mashed raw materials for making POC, (2) 5 liters of pre-prepared starter solution, (3) 1.5 kg of bran or 1.5 liters of rice washing water, (4) 1.5 liters of coconut water, (5) add the water to make the volume 20 liters, then stirred until entirely mixed.
- Close the drum, insert one end of the small hose into the hole in the drum cap so that it does not come into contact with the POC mixture inside, and insert the other end into the hole in the plastic bottle cap until the hose is immersed in water (the bottle is filled with water half the height of the bottle)
- The material was incubated for 4-5 days and stirred once a week by opening the drum cover.

2.4 Experimental Variables

Physical changes in raw materials, color, odor, temperature, and PH were observed during the incubation period. POC results were examined for micro and macronutrient content, as well as C-organic content. The Kjeldahl method was used to determine macro and micronutrient content, the atomic absorption spectrophotometer (AAS) method was used to determine P, K, CaO, MgO, and Fe, and the spectrophotometer method was used to determine C-organic content.

3. Results and Discussion

3.1 Changes in the Physical Appearance of Materials During the POC Manufacturing Process

The fresh raw material turns mushy, and the plant waste physically changes into white flour, but the fish and blood waste do not show any signs of white flour on the surface.

3.2 Change of Material Odor During POC making Process

Data on changes in the odor of POC materials are presented in Table 1.

Table 1: Change of Material Odor During POC making Process

No	POC raw material	Incubation observation on week ….				
		0	I	II	III	IV
1	P1 (mixed waste)	Original material	very rotten	bit smelly	bit smelly	Smelly
2	P2 (vegetable waste)	Original material	bit smelly	no smell	bit smelly	Tapay smelly
3	P3 (Fruit waste)	Original material	no smelly	Tapay smelly	Tapay smelly	Tapay smelly
4	P4 (sprout waste)	Original material	bit smelly	no smell	Tapay smelly	Tapay smelly

No	POC raw material	Incubation observation on week ….				
		0	I	II	III	IV
5	P5 (food waste)	Original material	very rotten	tapay smelly	Tapay smelly	Tapay smelly
6	P6 (catfish waste)	Fishy origin	Very rotten	Very rotten	Very rotten	Very rotten
7	P7 (waste blood)	Fishy origin	Very rotten	Very rotten	Very rotten	Very rotten

3.3 Material Color Change During POC Manufacturing Process

Data on material's color changes during the POC making process are presented in Table 2.

Table 2: Changes in Material Color During POC Manufacturing Process

No	POC raw material	Incubation observation on week ….				
		0	I	II	III	IV
1	P1 (mixed waste)	Brown	dark brown	dark brown	dark brown	Brown
2	P2 (vegetable waste)	light brown	brownish red	reddish brown	reddish brown	reddish brown
3	P3 (Fruit waste)	dark brown	light brown	light brown	light brown	light brown
4	P4 (sprout waste)	whitish brown	light brown	light brown	light brown	light brown
5	P5 (food waste)	Brown	light brown	light brown	light brown	light brown
6	P6 (catfish waste)	reddish brown	dark brown	dark brown black	dark Brown	dark brown
7	P7 (waste blood)	Red	blackish red	black	Black	Black

3.4 Changes in Temperature (°C) of Materials During POC making Process

Data on temperature materials changes during the POC making process are presented in Table 3.

Table 3: Changes in Temperature (°C) of Materials During POC Manufacturing Process

No	POC raw material	Incubation observation on week ….				
		0	I	II	III	IV
1	P1 (mixed waste)	30.5	28.9	28.6	29.5	27.2
2	P2 (vegetable waste)	29.6	27.3	28.9	27.8	27.3
3	P3 (Fruit waste)	29.7	27.5	27.1	28.2	27.8
4	P4 (sprout waste)	30.7	27.4	21.5	29.3	28.6
5	P5 (food waste)	29.3	28.4	28.1	29.1	27.1
6	P6 (catfish waste)	29.7	27.4	29.6	27.7	27.8
7	P7 (waste blood)	30.1	29.5	28.6	28.1	26.5

3.5 Changes in Material PH During POC making Process

Data on acidity changes (PH) of materials during the POC making process are presented in Table 4.

Table 4: Changes in PH of Materials During POC making Process

No	POC raw material	Incubation observation on week ….				
		0	I	II	0	IV
1	P1 (mixed waste)	3.8	4.0	7.4	5.5	4.5
2	P2 (vegetable waste)	4.9	3.7	5.6	3.6	3.9
3	P3 (Fruit waste)	5.0	3.3	5.9	3.4	4.8
4	P4 (sprout waste)	5.4	3.7	6.5	3.7	4.3
5	P5 (food waste)	5.1	4.9	7.2	3.1	4.3
6	P6 (catfish waste)	5.4	5.7	8.1	5.9	5.2
7	P7 (waste blood)	6.0	5.4	7.8	5.8	5.1

POC raw materials get through mechanical and chemical changes. Changes in the physical condition of the material, temperature, pH, color, and odor will follow the change caused by microbes (Rwoa'a et al., 2018; Nan-Hee An et al., 2013). The liquid fertilizer made from seaweed has a strong smell and a dark brown color. The color and aroma of liquid organic fertilizer indicate its maturity (Tsaniya et al., 2021).

3.6 Nutrient Content

Table 6 presents data analysis of nutrient content in liquid organic fertilizer made from seven types of organic waste.

Table 6: Plant nutrient content in POC using various types of organic waste as raw materials.

No	Variables/ ingredients in POC	POC raw materials						
		P1 Mixed waste	P2 Vegetable waste	P3 Fruit waste	P4 Sprout Waste	P5 Catering waste	P6 Fist waste	P7 Blood waste
1	Organic Ingredients (%)	20.34	20.81	21.05	17.98	22.15	21.10	19.88
2	N (%)	0.06	0.04	0.03	0.08	0.08	0.05	0.07
3	P (%)	0.06	0.08	0.09	0.09	0.06	0.08	0.04
4	K (%)	0.51	0.80	0.31	0.82	0.50	0.63	0.70
5	Organic C (%)	0.85	0.98	1.22	0.79	1.08	0.81	0.98
6	Mg (ppm)	4.01	2.86	3.02	3.08	2.26	4.12	3.88
7	Ca (ppm)	6.11	2.52	3.02	3.18	2.26	10.41	11.80
8	Cu (ppm)	0.86	0.69	0.65	0.52	0.56	0.78	0.82
9	Zn (ppm)	2.90	3.81	3.14	2.83	2.93	3.16	3.11
10	Fe (ppm)	0.15	0.12	0.11	0.05	0.08	0.07	0.13
11	Humic Acid (ppm)	3.85	5.22	6.05	4.12	4.95	7.32	6.50

3.7 Content of macronutrients

Organic matter in POC ranged from 17.98-21.05%, highest in food waste POC and lowest in sprout waste POC. The content of N elements ranged from 0.03-0.08%, highest in food waste and sprout waste and lowest in fruit waste. Phosphorus (P) ranged from 0.04-0.09%, highest in fruit waste, medium in sprout waste, and lowest in cow blood. The highest K content was sprout waste, and the lowest was fruit waste. The highest C-organic content was in food waste, and the lowest in sprout waste. The content of N, P, and K is relatively low compared to research by Govere et al. (2018) that found water hyacinth liquid fertilizer contains N (3.72%) and P (2.86%) and research by Kang et al. (2018) that found N, P, and K in fish waste liquid organic fertilizer were 2.26, respectively. 0.87 and 0.65%. According to the findings of the Lepongbulan 2017 study, fish waste POC contains high levels of nitrogen, phosphorus, and potassium. Fahlivi's 2015 research shows that fish waste contains 13.16% protein, 79.80% water, 0.20% fat, and 1.91% ash. Liquid organic fertilizer from fish waste contains a high concentration of macronutrients, including 2.11% nitrogen, 0.22% phosphorus, and 0.25% potassium (Hyun-Sug, 2020). The type of bioactivator and the incubation/fermentation period influence the nutrient content of POC (Raden et al., 2017).

3.8 Micronutrient content

Mg content ranged from 2.26 - 4.12ppm, with fish waste POC having the highest and food waste POC having the lowest. Ca content ranged from 0.26 - 11.80ppm, with blood waste having the highest concentration and food waste having the lowest. Cu content ranged from 0.52-0.86ppm, with blood waste having the highest and sprout waste having the lowest. Zn content ranged from 2.83 - 3.81ppm, with vegetable waste POC having the highest concentration and sprout waste POC having the lowest. The elemental content of Fe ranged from 0.05-0.15ppm, with cow blood waste having the highest elemental content and sprout waste having the lowest. The humic acid content ranged from 4.12- 7.32 ppm, with fish waste having the highest concentration and sprout waste having the lowest. The study results are consistent with the findings of Kuncaka et al. (2021), who concluded that the optimal ratio of N, sulfur, and iron in the POC of blood and chicken feather waste. Research by Ranasinghe et al. (2019) concluded that fish waste POC contains the highest phosphorus (0.05%), potassium (0.34%), calcium (0.26%), and magnesium (0.04%). According to Phibunwatthanawong and Riddech 2019. POCs of various sugarcane processing wastes have the following chemical parameters: pH 4.5–7.8. N-total 0.14–0.33 %, total P_2O_5 0.002–0.017 %, total K_2O 0.81–11.8%, organic matter 0.26–3.25%, C-organic 0.26–3.20% and C:N ratio 6.14–17.92. Blood and chicken feather solid organic fertilizer contain 4.67% N, 1.63% sulfur, and 3694.56 ppm iron, while the POC of blood and chicken feathers contains 3.76% N, 1.80% sulfur, and 221.56 ppm iron (Kuncaka et al., 2021).

4. Conclusions

Changes in texture, color, odor, PH, and temperature of the material occur during making POC. The material texture changes from the original condition to being crushed and soft, the odor changes from the aroma of the original material to the aroma of tapay, and for the material from fish waste and blood waste has a pungent smell in the end. The color changes from the color of the original material to dark brown. Liquid fertilizer from urban organic waste contains complete nutrients, including organic matter 17.98-22.15%, N 0.03-0.08%, P 0.04-0.095, K 0.31-0.825, C-organic 0.79-1.22%, Mg 2.26-4.12 ppm, Ca 2.26-11.80 ppm, Cu 0.52-0.86 ppm, Zn 2.83-3.83 ppm, Fe 2.83-3.81 ppm, and humic acid 3.85-7. POC made from fish and animal blood waste has a higher nutrient content than POC from plant waste, but it also produces odor during production, making people uninterested. Thus, it is suggested that the next research is to discover a method for producing odorless POC from fish waste and animal blood.

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