Utilization of Sludge from the Communal Wastewater Treatment Plant (WWTP) in the Asrama Dinas Lingkungan Hidup (DLH) Jagakarsa of South Jakarta City as Basic Material for Organic Fertilizer

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Abstrak

Asrama DLH Jagakarsa memiliki instalasi pengolahan air limbah komunal (IPAL) yang menghasilkan lumpur yang belum diolah. Warga Asrama DLH langsung menggunakan lumpur dari IPAL komunal tersebut sebagai pupuk untuk tanaman. Lumpur feses mengandung zat organik yang memberikan nutrisi bagi tanaman. Namun, ada kemungkinan masih mengandung bakteri patogen dan logam yang dapat membahayakan tanaman. Penelitian ini bertujuan untuk memanfaatkan lumpur feses dari IPAL Asrama DLH Jagakarsa sebagai pupuk organik dengan tambahan bahan berupa asam humat. Selama pembuatan pupuk, bakteri dan logam dihilangkan. Analisis yang digunakan meliputi analisis kondisi proses pengomposan, uji karakteristik untuk menentukan kandungan feses dan pupuk, serta analisis aplikasi pada tanaman. Analisis kondisi dalam proses pengomposan adalah analisis nilai pH pupuk organik. Uji karakteristik meliputi variasi tanah (V1), lumpur IPAL (V2), dan pupuk organik (V3). Analisis aplikasi pertumbuhan tanaman dilakukan dengan menguji variasi tanah 100% (P1), tanah 80% + 20% lumpur feses (P2), dan tanah 80% + 20% pupuk organik (P3). Analisis laboratorium meliputi analisis nitrogen, fosfor, kalium (NPK), dan kandungan air yang akan dibandingkan dengan standar mutu Keputusan Menteri Pertanian Nomor 261 tahun 2019. Tanaman yang digunakan sebagai indikator keberhasilan pupuk organik dalam pertumbuhan tanaman adalah tanaman kangkung. Nilai terbaik diperoleh pada variasi pupuk organik (V3), yaitu kandungan NPK dan kandungan air masing-masing sebesar 4,52%, 2,57%, 0,05%, dan 19,84%. Ini menunjukkan bahwa pupuk organik meningkatkan unsur NPK dan pertumbuhan tanaman.

Keywords: pupuk organik, IPAL, lumpur, tanaman, asam humat.

Abstract

Asrama DLH Jagakarsa has a communal wastewater treatment plant (WWTP) that produces sludge that has not been treated. Asrama DLH residents directly apply the sludge from the communal WWTP as fertilizer for plants. Fecal sludge contains organic substances that provide nutrients to plants. However, there is a possibility that it still contains pathogenic bacteria and metals that can be harmful to plants. This research aims to utilize the fecal sludge from Asrama DLH Jagakarsa WWTP as organic fertilizer with additional ingredients in the form of humic acid. During fertilizer manufacturing, the bacteria and metals are removed. The analysis used includes the composting process conditions analysis, characteristics tests to determine the content of feces and fertilizers, and analysis of the application to plants. Analysis of the conditions in the composting process is the analysis of the pH value of organic fertilizers. Characteristic tests include soil variation (V1), WWTP sludge (V2), and organic fertilizer (V3). Analysis of the application of plant growth was carried out by testing the variation of soil 100% (P1), soil 80% + 20% fecal sludge (P2), and soil 80% + 20% organic fertilizer (P3). The laboratory analysis includes the analysis of nitrogen, phosphorus, potassium (NPP), and water content which will be compared with the quality standard of the Decree of the Minister of Agriculture Number 261 of 2019. The plant that is used as an indicator of the success of organic fertilizer in plant growth is the kale plant. The best value was obtained in the variation of organic fertilizer (V3), namely the NPP content and water content, respectively, which were 4.52%, 2.57%, 0.05%, and 19.84%. This shows that organic fertilizer increases NPP elements and plant growth.

Keywords: organic fertilizer, wwtp, sludge, plant, humic acid

Introduction

Jakarta City has the highest population density in Indonesia, reaching 10,609,681 people with a total area of 664.01 km^2 (Badan Pusat Statistik, 2021) and have significance impact to environment (Suryawan and Lee, 2023; Sari et al., 2023, Ulhasanah et al., 2022). Based on data released by the Dinas Kesehatan DKI Jakarta in 2021, it is stated that around 7% of all identified Jakarta residents are still practicing open defecation or commonly referred to as buang air besar sembarangan (BABs) (Paat, 2021). To overcome these problems, the government, through the Ministry of Public Works and Public Housing (Kemen-PUPR), has built communal wastewater treatment plant (WWTP) facilities known as community-based sanitation or sanitasi berbasis masyarakat (SANIMAS) in various regions (Priatna, 2014).

WWTP is a facility that functions as a liquid waste treatment facility. The liquid waste generally comes from water closets (WC), washing water, industrial liquid waste, and so on, so that it is safely disposed of into the environment (Safitri, 2020). Residues from WWTP are WWTP sludge which needs to be cleaned regularly because the sediments of WWTP sludge can potentially cause disease and odor, pollute the soil, and become a medium for the development of pests and diseases (Agustin, 2006). Despite the dangers caused if WWTP sludge is not treated, WWTP sludge still contains high organic matter, which provides nutrition in the form of macronutrients needed by plant growth, namely nitrogen, phosphorus, and potassium elements (Ditjen Cipta Karya, 2018).

Asrama Dinas Lingkungan Hidup (DLH), Jagakarsa District, South Jakarta City, is one of the locations for the construction of the SANIMAS communal WWTP program. Based on field observations, the Asrama DLH Jagakarsa residents have used WWTP sludge directly as plant fertilizer. Apart from that, there are regulations drawn up by the Asrama DLH management for the residents, where each house must have at least 20 plants and participate in farming in a shared garden.

This research aims to make organic fertilizer with the basic ingredient of WWTP sludge and also refers to previous research regarding the best composition used, so the yield of organic fertilizer made from WWTP sludge meets the current quality standards from the Decree of the Minister of Agriculture Number 261 of 2019 concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvement. In addition to comparing nitrogen, phosphorus, and potassium (NPP) values with government regulations, fertilizer quality tests were also carried out on plants to ascertain their effect on plant growth. Parameters that need to be observed include plant height growth, leaf width, and the number of leaves (Raharja, 2011). Through this research, it is hoped that the residents of Asrama DLH can utilize existing WWTP sludge as a basic ingredient for making organic fertilizer to increase plant fertility.

Materials and Methods

This research includes literature studies, field studies, laboratory tests, and trials on plants. There are several processes to turn WWTP sludge into organic fertilizer. The first is sludge sampling at the communal WWTP of Asrama DLH, followed by laboratory tests to determine the amount of NPP nutrients and the water content of the WWTP sludge. Furthermore, the preparation stage contains drying, mashing, and sieving to produce the uniform WWTP sludge shape. This study used an additional ingredient in the form of humic acid because it contains NPP, which meets the quality standards of the Decree of the Minister of Agriculture Number 261 of 2019. In addition, the reason for choosing humic acid is to prioritize its use for the residents of Asrama DLH, such as low prices (economic aspects) and requiring a fast time in composting.

In this study, the organic fertilizer was a mixture of humic acid and WWTP sludge with a ratio of 1:150 (Raharja, 2011). These comparisons and compositions are the best values from previous studies that have succeeded in making organic fertilizer from WWTP sludge. The mixed humic acid and WWTP sludge are then composted by examining the pH value to ensure that the organic fertilizer has reached the maturity or stable phase for use as fertilizer for plants. Laboratory tests were also carried out related to NPP nutrients and water content of organic fertilizers. Next is the characteristic test by comparing the NPP values and water content of soil variations (V1) as a control, WWTP sludge variations (V2), and organic fertilizer variations (V3).

Results and Discussion

There are three analyzes carried out, namely condition analysis, laboratory analysis, and plant analysis. Condition analysis was carried out by measuring the pH value in the organic fertilizer composting process. The pH value is shown in Figure 1.

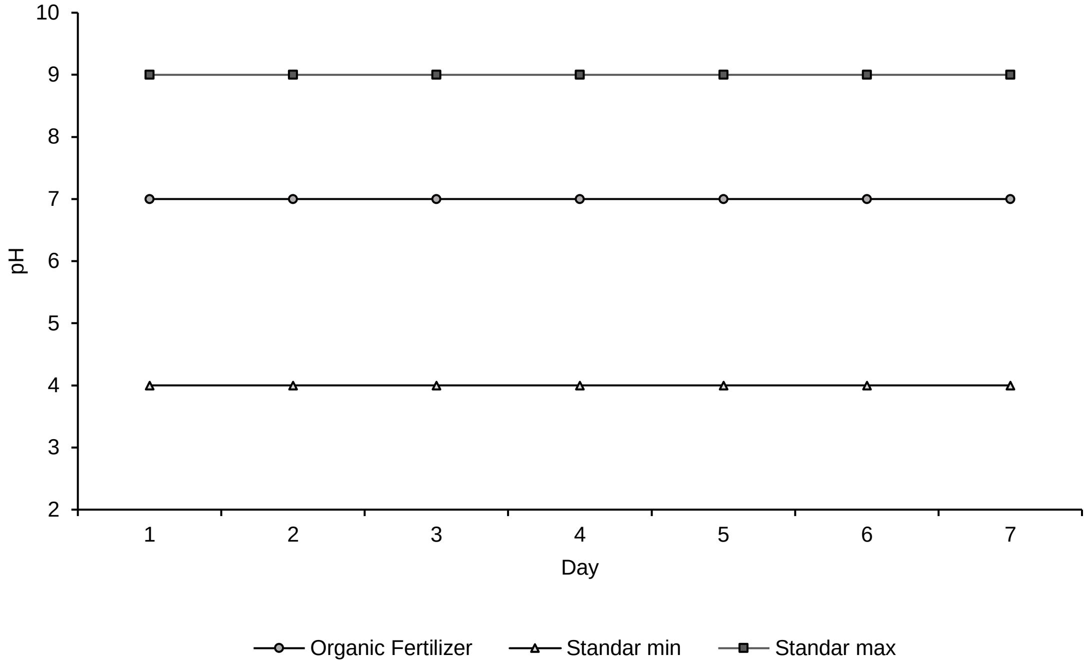

Figure 1. Measurement of pH for Seven Days

Figure 2. pH Measurement using a pH meter

The pH parameter results showed a stable value from the first to the seventh day. The factor affecting the pH value's stability is the maturation process during the WWTP sludge drying process. This value meets the quality standards of solid organic fertilizer in the Decree of the Minister of Agriculture Number 261 of 2019, with a pH value of 4 – 9. This value also indicates that the composting process of organic fertilizer has reached the maturity point so it can be used as organic fertilizer. At a neutral pH between 6.5 – 7.5, there are also many (optimal) amounts of macronutrients (Rosliani et a., 2005). Test characteristics of the elemental content of NPP and water content are shown in Figure 3 – 4, which shows a comparison of each variation.

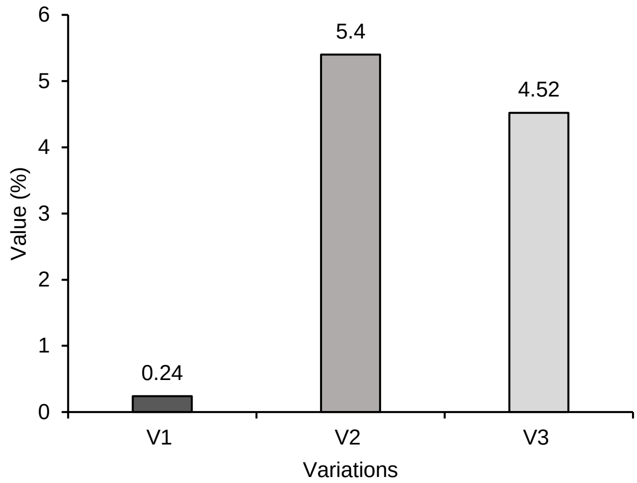

Figure 3. Results of Nitrogen Analysis for Each Variation

The smaller nitrogen content in V3 (organic fertilizer variation) compared to V2 (WWTP sludge variation) can be caused by nitrogen gas which evaporates during the drying and composting processes. The process occurs is that microbes convert organic materials into organic acids in the gas phase (Supriyanti et al., 2017)

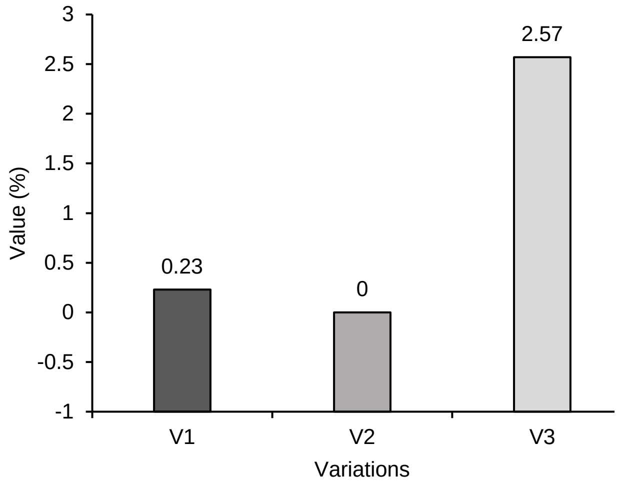

Figure 4. Results of Phosphor Analysis for Each Variation

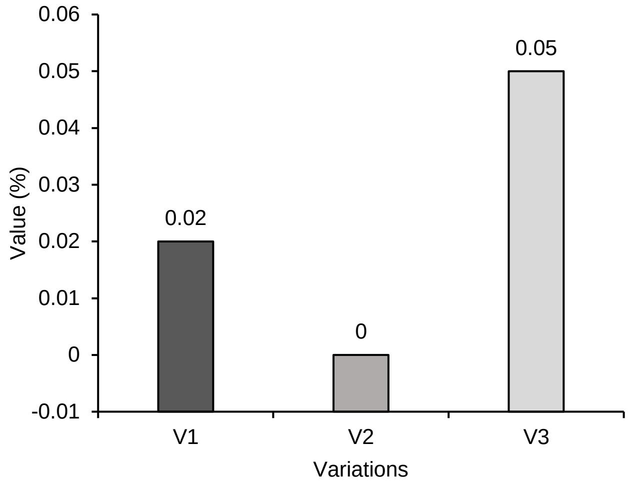

Figure 5. Results of Potassium Analysis for Each Variation

The low value of phosphorus from V2 (WWTP sludge variation) can occur because of the nature of phosphorus which can be adsorbed if Al and Fe elements are present. The availability of phosphorus in the soil can be increased by adding organic matter (Sari and Sudarsono, 2017). The organic matter directly affects the availability of phosphorus through mineralization processes and indirectly by helping to release fixed phosphorus. The decomposition of organic matter produces organic acids and releases adsorbed phosphorus. Organic materials will also bind to Al and Fe ions to reduce their solubility in the soil so that the availability of phosphorus increases.

Based on Figure 4, it can be seen that the phosphorus content in V3 (organic fertilizer variation) is greater than V1 (soil variation) and V2 (WWTP sludge variation). This shows that adding humic acid affects the quality of organic fertilizers. With organic matter, the value of phosphorus can be increased by removing the inhibiting ions.

The amount of potassium tends to be smaller than the parameters of nitrogen and phosphorus (Rosmarkam and Yuwono, 2002). This can happen due to potassium’s dynamic (mobile) nature and is easily soluble in water. The higher potassium value in V3 (organic fertilizer variation) compared to V1 (soil variation) and V2 (WWTP sludge variation) could be caused by humic acid containing 1.08% potassium added to organic fertilizers.

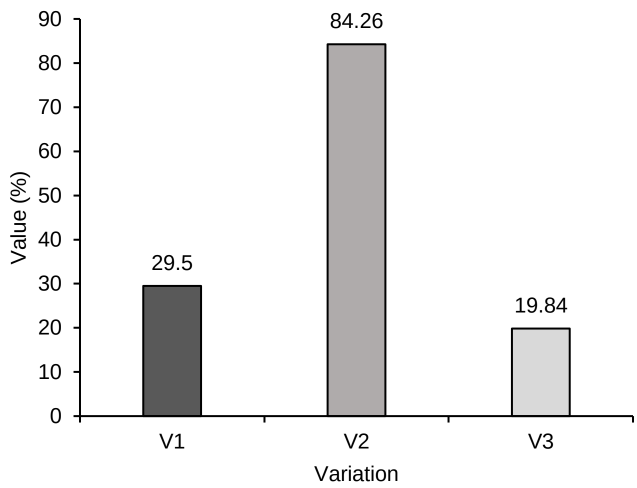

Figure 6. Results of Water Content Analysis for Each Variation

The high value of the water content in the WWTP sludge (V2) can be caused by the mixing between the WWTP sludge and wastewater in the WWTP. Meanwhile, the lower value of water content in organic fertilizers (V3) can be caused by the drying process after the completion of WWTP sludge laboratory tests. Steps taken to reduce the water content are by spraying air so that water can pass through the pores of the sample or can also be done by adding organic matter so that it can absorb water (Gapkindo, 2009). In this study, the steps taken to reduce the moisture content of V2 were drying in the sun and adding samples with organic matter in the form of humic acid.

The results of testing organic fertilizers (V3) and WWTP sludge (V2) have NPP macronutrients that meet the quality standard criteria for Decree of the Minister of Agriculture Number 261 of 2019, namely the elemental value of N + P_2O_5 + K_2O is more than 2%. Meanwhile, the value of the water content of organic fertilizers (V3) is also appropriate, which ranges from 10-25%.

Table 1. Overall Result Parameters of Each Variation

Parameter	Result (%)			Quality standard (%)[a]
	V1	V2	V3	
Nitrogen (N)	0.24	5.4	4.52	The minimum total amount of NPP is 2
Phosphor (P)	0.23	0	2.57	
Potassium (P)	0.02	0	0.05	
Water Content	29.5	84.26	19.84	10 – 25

[a] Decree of the Minister of Agriculture Number 261 of 2019

Conclusion

The sludge originating from the Asrama DLH Jagakarsa communal WWTP can be used as a basic ingredient for organic fertilizer because it has a nitrogen value of 5.4%, 0% phosphorus and potassium, and a moisture content of 84.26%. Phosphorus and potassium values can be supplemented with additional ingredients in the form of humic acid to meet the standard in the Decree of the Minister of Agriculture Number 261 of 2019. Organic fertilizers with humic acid and WWTP sludge ratio of 1:150 have a nitrogen content of 4.52%, phosphorus of 2.57 %, 0.05% potassium, and 19.84% water content. The NPP nutrient content and water content produced meet the quality standards of the Decree of the Minister of Agriculture Number 261 of 2019 so that it is suitable to be used as organic fertilizer for plants.

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