Assessing the Quality of Compost Tea Made from Swamp-Growing Lotus Plants

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Research Paper

Assessing the Quality of Compost Tea Made from Swamp-Growing Lotus Plants

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Abstract
Lotus is a wild plant in wetlands that have not been widely used but has great potential to be developed as compost tea. Therefore, this research aims to evaluate the content of compost tea made from wild lotus found in wetlands, which has not been sufficiently used but has great potential to be developed as compost tea. It was conducted by testing several methods and compositions of compost immersion, namely A1, A2, A3, and A4 at Aeration 1:5, Aeration 1:10, Non-aeration 1:5, and Non-aeration 1:10, respectively. The results show that the pH value increased until day 8 of immersion and then decreased on days 9 and 10, with a range of 8.0-8.44, in the recommended range. Furthermore, the total dissolved solids in the 1:5 water ratio were lower than the 1:10 of compost and water. The content of nutrients (C-organic, N-total, and P-available), bacteria population, actinomycetes, fungi, and humic acid concentration were higher in aeration treatments for both 1:5 and 1:10 compost and water ratios. In addition, humic acid functional groups in compost tea for all treatments were detected, including OH-phenolic, C=C, C=C, COOH, CH_3, secondary amides, and tertiary amides with different wavelengths. Based on these results, it can be concluded that aeration treatment provides better results for the observed variables than non-aeration.

Keywords
Compost tea, humid acid, liquid organic fertilizer, lotus, nutrient content

1. INTRODUCTION

The Lebak swamp in South Sumatra is a wetland that covers an area of 285,941 hectares and is flooded with water at certain times (Badan Pusat Statistik Provinsi Sumatera Selatan (BPS Sumsel), 2016). The Lebak swamp is heavily populated with wild plants, with one of the dominant species being the lotus (*Nelumbo nucifera*). This plant thrives in muddy and flooded soil and is widely found in swamp lands throughout Indonesia. Due to its great potential, it is worth exploring for further utilization (Salmiyah et al., 2017). Despite the potential of the lotus plant, its utilization is currently limited due to decreased technology and low public awareness of its functional benefits. However, the plant has many benefits in the food industry, such as for soy sauce, soybean cake, and tapai production (Chen and Tengku, 2020). It also has potential in the field of pharmacology as a medicine material and in agriculture for use in compost manufacturing.

Compost is a product of the decomposition of organic materials, which is often used as an agricultural input to improve land and increase crop production (Ho et al., 2022). One method of applying these organic materials is through the use of compost tea, an extract that is used to develop or enhance organic farming practices. Compost tea not only improves the nutrient content of plants, but it also serves as a bio-control for pests and diseases Martin (2014). Additionally, compost tea is an easily accessible source of nutrition for plants, and it increases water absorption and growth (Septitasari et al., 2021).

The production of compost tea can be carried out through aeration and non-aeration (Seddigh and Kiani, 2018). Aeration production is extracting compost tea by inserting an aerator into the extract container to add oxygen. Meanwhile, non-aeration is the process of extracting compost tea without involving oxygen. Aeration compost tea contains the most sodium (Na) and molybdenum (Mo), but the highest levels of potassium (K), zinc (Zn), and manganese (Mn) are in non-aeration (Seddigh and Kiani, 2018). Research has shown that compost tea contains essential elements for plant growth and resistance, such as NO_3^-, K_2O, humic acid, and various microorganisms, these include aerobic bacteria, N2-fixing bacteria, and actinobacterial (González-Hernández et al., 2021). An increase in the average population density of bacteria in all types of aerated compost tea was incubated for three days (Kim et al., 2015), and it was reported that the immersion time affected the pH and EC values (Eudoxie and Martin, 2019). The longer the immersion time, the higher the pH, but the EC value decreases. Based on the analysis of nutrient content and humic acid of compost tea made from orchard waste (ACT) and vermicompost (AVT), the total N, NO_3^-, K_2O, and humic acid in AVT (compost tea made from vermicompost) tend to be lower than ACT (compost tea made from orchard waste). However, NH_4^+, P_2O_5, Ca, and Mg content tend to be close in each type of compost tea (Morales-corts et al., 2018). The total N content in the compost tea made from orchard waste reached 3840.6 ppm, which can increase the productivity of the plants.

Based on the above description, it is known that various types of organic materials can be used as a source of compost tea containing nutrients. Since lotus has not been widely used, this research aims to evaluate the content of compost tea made from this plant produced with and without aeration through several compost immersion ratios and water.

2. EXPERIMENTAL SECTION

2.1 Research Location and Time

This research was conducted from July to August 2023 and started with the compost and compost tea manufacturing at the shade house of the Agriculture Faculty, Universitas Sriwijaya. It was followed by the analysis at the Chemistry Laboratory of UIN Raden Fatah and the Integrated Laboratory of Bina Sawit Makmur Company (Sampoerna Agro Tbk.).

2.2 Compost Tea Manufacturing

Compost tea manufacturing was performed by taking lotus plants from the swamp area in Palembang City. The additional materials used were cow manure as a starter to enrich the population of decomposing microorganisms. Furthermore, the manufacturing process started by chopping the stem and leaves to a size of approximately 1 cm. The resulting materials were mixed with cow manure with a ratio of 5:1 (w/w), and the mixture was incubated and stirred daily for four weeks. The mature compost had general criteria such as texture and smelled like soil. It was sieved to obtain the same particle size and soaked in water with a ratio of 1:5 and 1:10 (w/v). The compost tea was made with two methods, namely aeration and non-aeration. The production of compost tea with the aeration and non-aeration methods was carried out with an aerator and without oxygen. Subsequently, the immersion was performed for ten days, and on day 3, samples were taken for laboratory analysis.

2.3 Analysis of Compost Tea Content in the Laboratory

The variables observed from the compost tea are the pH value, total dissolved solids, C-organic, N-total, P total, C/N ratio, and humic acid content. The pH value and total dissolved solids are observed on days 1 to 10 of soaking using a pH meter and TDS meter. Meanwhile, the analysis

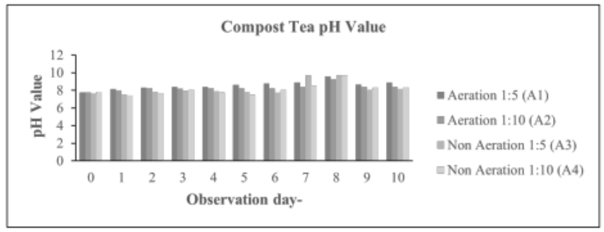

Figure 1. pH value of compost tea during ten days of soaking.

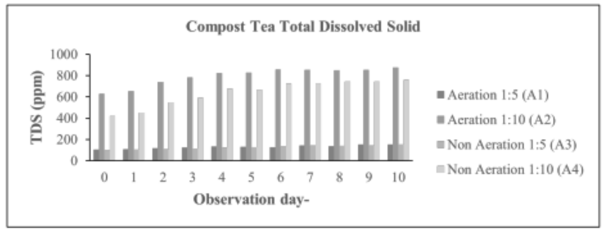

Figure 2. Total dissolved solids in compost tea during ten days of soaking.

of C-organic, N-total, P total, and C/N ratio is carried out in the Integrated Laboratory of Bina Sawit Makmur Company (Sampoerna Agro Tbk.) using the compost tea sample on day 3. ... [Description of the detailed analysis procedures].

2.4 Data Analysis

The data from the observations (pH value, TDS, population of microorganism, and humic acid concentration) were presented in tables and graphs, while other observation data (N, P, C organic, and C/N ratio) were analyzed statistically using Analysis of Variance (ANOVA) and post hoc test by using LSD test of 5% significant level and also presented in graphs which were interpreted and discussed in paragraphs, supported by several reputable journal references.

3. RESULT AND DISCUSSION

3.1 pH Value

Based on the observations for ten days of soaking, the pH data shows fluctuations in treatment and time. The pH value is relatively high during the soaking, and increases from days 0 to 8, then decreases on days 9 and 10 (see Figure 1). Meanwhile, aeration and non-aeration treatments, as well as water and compost tea ratios, do not show any difference in pH. The compost tea pH value in the final observation of all treatments ranges between 8.0 to 8.4 and falls within the recommended range, as reported in the research by El Haddad et al. (2014) from 7.2 to 8.4.

It showed that the pH values of the observations on various compost tea production treatments, with an increase on day 8 (Figure 1). The high pH is in line with the re-

Table 1. The population of bacteria, actinomycetes, and fungi in the compost tea with various treatments

Treatment	Bacterial population (log cfu g-1)	Actinomycetes population (log cfu g-1)	Fungal population (log cfu g-1)
Aeration 1:5 (A1)	7.26	4.81	3.16
Non-aeration 1:5 (A2)	5.18	3.54	3
Aeration 1:10 (A3)	8.11	5.55	5.81
Non-aeration 1:10 (A4)	5.83	3.95	4

Table 2. The humid concentration of compost tea with various treatments

Treatment	Concentration (mg L-1)	Wavelength 324.0
Solid compost (A0)	656.508	1.395
Aeration 1:5 (A1)	304.73	0.653
Aeration 1:10 (A2)	164.034	0.356
Non-aeration 1:5 (A3)	275.415	0.591
Non-aeration 1:10 (A4)	45.174	0.105

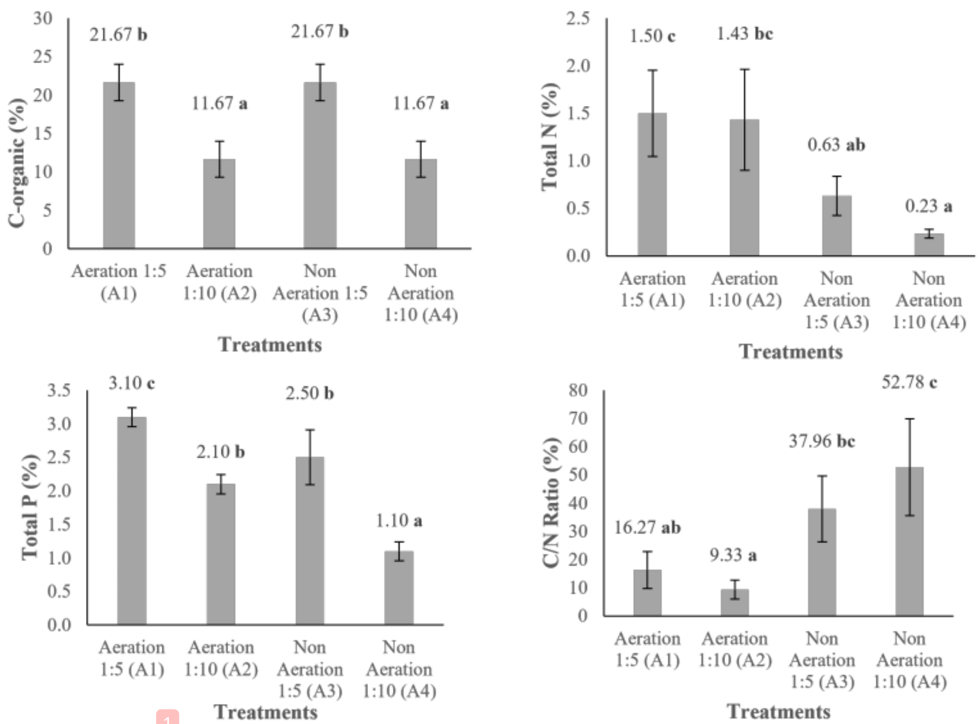

Figure 3. Content of C-organic, Total N, Total P, and C/N ratio in the compost tea with various treatments.

sults of measuring functional groups in humic acid using an FTIR spectrophotometer (see Figure 5). The detected functional groups include OH-phenol, C=O, C=C, aromatic ether, tertiary amide, CH3, secondary amide, OH-bending, and CH-bending in solution to release OH- anions which cause the pH of the compost tea solution to increase. On days 9 and 10, pH decreases in all treatments at the end of incubation due to the production of CO2 by microbial activity, which forms carbonic acid (Sari and Dwiyati, 2015).

3.2 Total Dissolved Solids

The Total Dissolved Solids (TDS) measure inorganic and organic substances (Nicola, 2015). TDS is caused by inorganic substances that dissolve ions in water (Effendi, 2014) and are measured during the day 10 soaking for each treatment (see Figure 2).

The TDS for the ratio of compost and water is 1:5, both aeration and non-aeration are lower than the obtained value with a ratio of 1:10 (see Figure 2). This is because the ratio of 1:5 cannot dissolve the organic and inorganic substances from the compost due to limited water. Meanwhile, in the ratio of 1:10, there is enough water to dissolve the solids in the compost, increasing the TDS. Water helps to dilute some nutrients or substances in the soil for plants' needs (Kiss et al., 2021).

3.3 The Content of C-organic, N-total, P-total, and C/N Ratio

The analysis result of the content of C-organic, N-total, P-total, and C/N ratio in various treatments is shown in Figure 3. The organic C-organic content in the 1:5 compost and water ratio treatment is 21.67%, higher and significantly different than the 1:10, which is 11.67% for both aeration and non-aeration treatments. This research showed that the 1:5 compost and water ratio treatment causes the C-organic content in compost tea to be higher than ratio of 1:10. The higher aromatization, molecular weight, and humification levels in the aeration treatment are due to more oxygen availability (Li et al., 2021).

The C/N ratio is calculated based on the content of C-organic and N-total in the compost tea. The C/N ratio of non-aeration compost tea was higher and significantly different than the non-aeration treatments. The highest and lowest ratios are in the non-aeration and aeration treatments with 1:10. It is also believed that the number of microorganisms affects the C/N ratio. The results report that a lack of microbial activity causes a high C/N ratio because microorganisms take longer to degrade the materials (Jarboui et al., 2021). Anaerobic decomposition of organic matter takes longer than aerobic (Rodríguez-Ballesteros et al., 2020).

3.4 The Population of Bacteria, Actinomycetes, and Fungi

The population of bacteria, actinomycetes, and fungi was counted on day 3 of compost immersion (see Table 1). The population increases with the increasing dilution level from 1:5 to 1:10. Meanwhile, non-aeration treatment causes a decrease in bacteria, actinomycetes, and fungi. Anaerobic conditions can limit the growth of microorganisms (Zaccardelli et al., 2011), as in the results of this research. Microorganisms gain more energy from aerobic reactions than anaerobic (Maksimovich et al., 2021).

3.5 Humic Acid Content

The FTIR method analyzed the humic acid content in the day 3 compost tea immersion results for each treatment. The results show the comparison of pure humic acid and solid compost FTIR (see Figure 4) and also the humic acid content each treatment (see Figure 5). …[Detailed FTIR analysis results and their interpretations].

Furthermore, the concentration of humic acid is presented in Table 2, where solid compost (A0) contains the highest value of 656.508 mg/L and treatment non-aeration 1:10 (A4) is the lowest value of 45.174 mg/L. In the same comparison between aeration and non-aeration compost tea, the humic acid concentration in the aeration compost tea was higher than the non-aeration compost tea. This is suspected to be due to the difference in water used in dissolving the compost. Aerobic conditions maintain and promote the presence and growth of beneficial soil microorganisms (Araujo et al., 2017). Additionally, the aeration compost tea treatment utilizes aerobic microbes to accelerate the release of organic acids during the manufacturing process, resulting in a higher concentration of humic acid (Palese et al., 2021).

4. CONCLUSION

Based on the results, it can be concluded that the aeration treatment provides better results on the observed variables than the non-aeration. The pH value of each treatment for ten days of observation ranged from pH 7 to 8. Furthermore, the total dissolved solids in the 1:5 water ratio were lower than in the 1:10 compost and water ratio. Nutrient levels (C-organic, N-total, and P-available), populations of bacteria, actinomycetes, fungi, and humic concentrations were higher in the compost and water ratio of 1:5, especially in aeration treatment. Moreover, functional groups in compost tea humic acid for all treatments measured using an FTIR spectrophotometer were detected, including OH-phenol, C=C, C=C, COOH, CH3, secondary amide, and tertiary amide groups, closely resembling the functional groups of pure humic acid.

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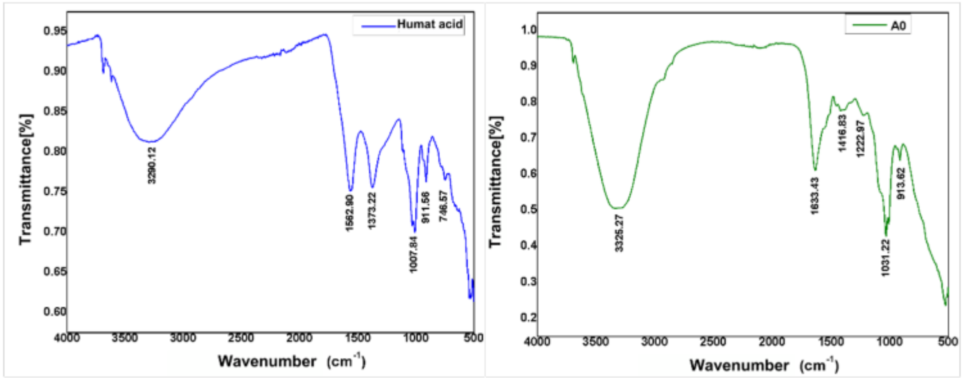
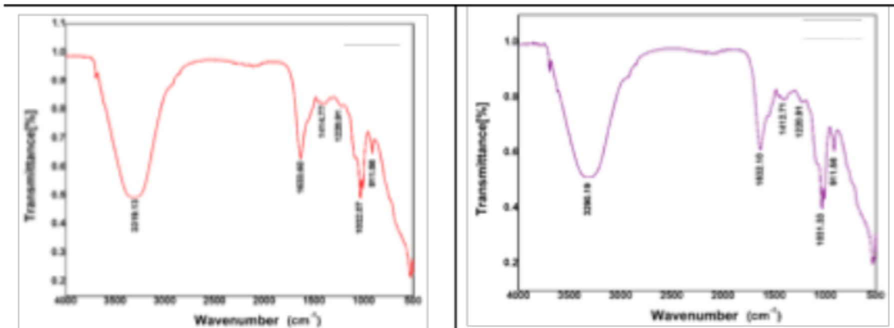


FTIR spectrum results of pure humic acid **FTIR spectrum results of solid compost**

Figure 4. FTIR spectrum results for each treatment.



FTIR spectrum results of treatment of Compost tea Aeration 1:5

FTIR spectrum results of treatment of Compost tea Aeration 1:10

FTIR spectrum results of treatment of Compost tea Non Aeration 1:5

FTIR spectrum results of treatment of Compost tea Non-Aeration 1:10

Figure 5. FTIR spectrum results for each treatment.

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