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The Effect of Starbo AFE and Probio FM Activators on the Quality of Water Hyacinth Compost (*Eichhornia crassipes*)

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Abstract: Water hyacinth (*Eichhornia crassipes*) is a water-dwelling weed characterized by its high growth rate. It can increase evapotranspiration (the combination of evaporation and water loss through plant leaves), reduce the amount of light entering the water, resulting in a decrease in oxygen solubility, disrupt water flow, and increase habitat for disease vectors in the aquatic environment. A solution is needed to overcome this problem, one of which is composting. To accelerate composting, Starbo AFE and Probio FM activators are used, which provide high-quality compost. This study aims to investigate the impact of various activators on the nutrient content of water hyacinth compost and to identify the optimal combination of activators for enhancing the nutrient content of water hyacinth compost. This study approach employs a single replication with three treatments (K1, K2, and K3 with Starbo AFE and Probio FM, and K0 without Starbo AFE and Probio FM). This study was executed in two phases, specifically the composting phase. The composting procedure was conducted for 30 days. Checks are carried out every 5 days through turning and physical observation. After the composting process is complete, nutrient measurements are carried out. Characterization is carried out to determine the levels of C-Organic, N, P, K, and Aroma. The results of this study showed that Starbo AFE and Probio FM are effective in reducing C-organic, N, and K levels, and in improving aroma, thereby meeting SNI standards.
Keywords: *starbo AFE, prorobio FM, water hyacinth, compost, activator*

1. Introduction

Compost is the result of the decomposition of organic materials, such as food waste, leaves, and grass, that have undergone a decomposition process facilitated by microorganisms, including bacteria and fungi, into an organic fertilizer. The composting process transforms organic materials into fertilizers rich in nutrients for plants, thereby improving soil structure. The composting process is significantly influenced by activators [1], which are materials containing microorganisms, such as bacteria and fungi, that accelerate the decomposition of organic materials into compost or fertilizer. This activator is important for processing organic waste, enriching the soil, and increasing fertility [1]. Numerous product activators on the market are incredibly similar to ones we are already familiar with. Some products are comparable to those from the study college that still need to be developed, including Probio FM and Starbo AFE. Probio FM is a liquid probiotic containing several species of lactic acid bacteria, which are the result of microbial isolation taken from the digestive tract of kerinci ducks [2].

Probiotics work by reducing the number of harmful microorganisms in the intestine, thereby helping to maintain the balance of microflora within the intestine. The use of Probio FM can increase livestock productivity, specifically by enhancing weight gain, improving appetite, and reducing production costs [3]. Probio FM is a liquid probiotic containing several species of lactic acid bacteria, which are the result of microbial isolation taken from the digestive tract of kerinci ducks.

Starbo-AFE is a starter produced to quickly break down organic materials with high fibre content, such as agricultural and livestock waste, which can reduce unpleasant odours and decompose organic market waste [4]. The microorganisms contained in StarboAFE are derived from the isolation of bacteria from goose digestive tracts, as well as yellow bamboo roots from peatlands, and microbes from empty oil palm bunches. The results of isolating microorganisms are consolidated into a Starbo-AFE product [5].

Water hyacinth (*Eichhornia crassipes*) is an aquatic vegetation that floats on the surface of water, which has a rapid growth rate, potentially harming the aquatic ecosystem, including increasing evapotranspiration (evaporation and loss of water through plant leaves), reducing the amount of light entering the water, causing a decrease in the level of oxygen solubility in water, accelerating the shallowing process, disrupting water traffic, increasing the habitat for disease vectors in humans and reducing the aesthetic value of the aquatic environment [6].

Several studies have demonstrated that water hyacinth can serve as an alternative source of organic materials. Utilization of water hyacinth as a water waste, one of which is by making organic fertilizer. The N content of water hyacinth can aid plant growth. Water hyacinth has an organic material content of

25.16, organic C of 19.61%, N of 1.86%, P of 1.2%, K of 0.7% and a C/N ratio of 6.18% which is useful for plant growth [7]. The use of water hyacinth as compost can improve the physical structure of the soil and increase nutrient availability, encouraging plant growth.

Water hyacinth possesses beneficial qualities, including the ability to absorb heavy metals and sulfide compounds. Additionally, it contains 11.5% protein and non-cellulosic components including lignin, ash, and fat, which are present in smaller quantities than cellulose itself. Moreover, water hyacinth contains essential nutrients for plants, specifically nitrogen (N), phosphorus (P), and potassium (K). The research is to (i) assess the impact of activator type on the nutrient composition of water hyacinth compost, and (ii) identify the optimal combination of activators for enhancing the nutrient content of water hyacinth compost.

2. Materials and Methods

2.1. Tools and materials

The tools used in this study were three plastic containers, knives, sprayers, scales, and thermometers. The materials used were water hyacinth, molasses, Starbo AFE, Probio FM, and water. The research method used was the experimental method. This study used three treatments and three replications. The treatment carried out is as follows.

Treatment 1: Water hyacinth compost without starter (K0)
Treatment 2: Water hyacinth compost with Starbo AFE (K1)
Treatment 3: Water hyacinth compost with Probio FM (K2)
Treatment 4: Water hyacinth compost with Starbo AFE and Probio FM (K3)

2.2. Procedures Composting

Water hyacinth is chopped and then dried for one day to reduce its water content. Then, they weighed as much as 15 kg for each container. Place 15 kg of the material into four perforated containers, then add the activator according to the treatment. Then each container is tightly closed. The composting process is left for 30 days. During the composting process, the condition of the compost is regularly checked, and the material is turned every 5 days to maintain aeration, porosity, and moisture levels. After the composting process is complete, the temperature and pH are measured.

2.3. Parameters

The parameters observed are divided into two stages: composting and characterization. In the preparation stage, the parameters observed are temperature and pH. While in the characterization stage, were C-Organic, nutrient content (N, P, K), water content, and Aroma.

2.3.1. C-Organic Content

Determination of C-Organic via the SNI 7763:2024 method through ashing at a temperature of 550 to 600 °C, resulting in the conversion of organic matter to CO_2 and metals to their respective oxides. The mass of the lost material is organic matter that can be transformed into C-organic content by multiplying by a factor of 0.58, as demonstrated in equation 1.

$$\text{C} - \text{organic content (\%)} = \text{\% content of material organic} \times 0{,}58 \times \text{fk} \quad (1)$$

2.3.2. Nitrogen (N) Content

Determination of Nitrogen Content (N) using the SNI 7763:2024 method, with the principle of Nitrogen (N-organic and N-ammonium) in the sample is hydrolyzed with sulfuric acid to form ammonium sulfate $(NH_4)_2SO_4$ and nitrate compounds. Nitrate compounds with salicylic acid form nitro salicylate, then are reduced with sodium thiosulfate to form ammonium compounds. Ammonium compounds in alkaline conditions are distilled, then collected in boric acid, and titrated with sulfuric acid solution until the green color changes to pink. The calculation of which can be seen in equation 2.

$$\text{N content (\%)} = \frac{(V1-V2)\times N \times 14{,}008}{w} X100\%\, X\, fk \quad (2)$$

2.3.3. Phosphorus (P) Content

Determination of Phosphorus (P) Level using SNI 7763:2024 method with the principle of wet oxidation with nitric acid (HNO_3) and perchloric acid ($HClO_4$). The extract obtained is used to measure the P element by; Pipette 1 ml of extract into a 20 ml volume chemical tube, as well as each series of P working standards; Add 9 ml of dilute molybdate phosphate reagent to each sample and working standard series, shake with a vortex mixer until homogeneous; Let stand (15 - 25) minutes, then measure with a spectrophotometer at a wavelength of 889 nm (maximum λ adjusted to the condition of the tool) and record the absorbance value. The calculation of which can be seen in equation 3.

$$P_2O_5 \text{ content (\%)} = \frac{v}{1000} X \frac{100}{W} X \frac{142}{62} X100\%\, X\, fk \quad (3)$$

2.3.4. Potassium (K) Content

Assessment of Potassium (K) Concentration utilizing the SNI 7763:2024 methodology, based on the principle of wet oxidation employing nitric acid (HNO_3) and perchloric acid (HClO4). The resulting extract is utilized to quantify the K element by Transfer 1 ml of extract into a 20 ml volumetric tube. Introduce 1 ml of lanthanum (III) chloride ($LaCl_3$) solution and dilute to 10 ml with a 0 mg/l standard solution, then vortex until homogenous. Determine the absorbance of the solution via an SSA instrument or flame photometer at a wavelength of 766.5 nm, as outlined in equation 4.

$$\text{K2O content (\%)} = \frac{v}{1000} X \frac{100}{w} X \frac{94}{6278} X 100\% \; X \; fk \quad (4)$$

2.3.5. Aroma

The sensory evaluation method for the scent of water hyacinth compost involves an aroma assessment conducted by eight panelists to determine the degree of organic matter decomposition in the compost, based on the odor emitted after 30 days. Panelists will evaluate the odor characteristics according to the composting stage utilizing a preference scale of Pungent odor (+), earthy odor (++), and humus-like odor (+++).

3. Results and Discussion

Observations of water hyacinth compost include C- organic content, nutrients (N, P, K), and aroma. [8]Stated that the most important physical and chemical parameters measured were pH, C, N, water content, and organic matter.

3.1. C- Organic content

The C-Organic content was assessed following a 30-day composting period. The treatment analysis results for Probio FM and Starbo AFE concerning C-Organic content. Figure 1 illustrates the composition of the activator treatment.

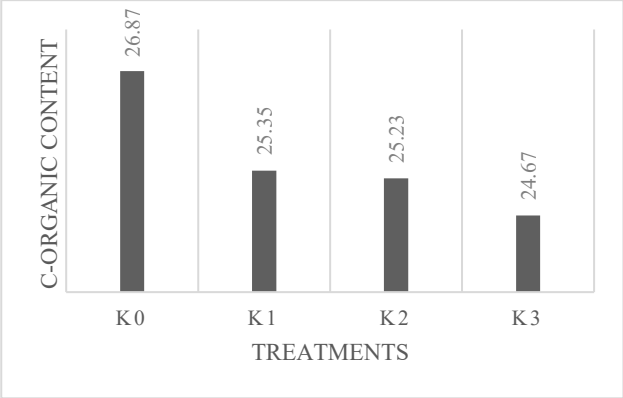

Figure 1. Influence Probio FM and Starbo AFE on Organic C Levels in Compost water hyacinth

Carbon is the main element in organic matter. Changes in organic C are caused by the activity of microorganisms that consume organic matter from compost as a source of energy in the formation of cells by releasing CO_2 and H_2O [9]. The more water produced, the lower the carbon content. [10]. From the picture above, it can be seen that the organic C obtained for K3, K2, K1, and K0 are 26.87, 25.35, 25.23, and 24.67, respectively.

The use of activators in the composting process accelerates the decomposition of organic matter by microorganisms. However, a process that is too fast or intensive can cause a decrease in C-organic levels because carbon is used as a source of microbial energy and is mostly released as CO_2 gas. In addition, raw materials with a low C/N ratio also contribute to low C-organic levels in the final compost. As a result, the resulting compost has a C-organic content below the required quality standards (≥15%).

K3 has the least amount of C-organic material, which aligns with the study's [12] findings that composting organic material with inoculum has a lower C-organic content than composting organic material without inoculum. It happened because adding activators increases the number of microorganisms, which means that more microbes are involved in breaking down water hyacinth. Even though treating compost without an activator does not add an activator to speed up the composting process. It causes the microorganisms that play a role to be fewer compared to those treated with activators. The small number of microorganisms involved means that the energy produced is also modest, resulting in a higher C-organic content [11]. The results of this study indicate that the C-organic content in water hyacinth compost is by SNI (9.8-32%), on the quality of chemical, physical, and microbial properties of agricultural waste compost, that the C-organic content obtained is 22-25 [12].

3.2. Nitrogen (N) Content

The nitrogen content was analyzed after the compost had been composted for 30 days. Based on the analysis of the observed variables, various treatments were administered. Probio FM and Starbo AFE did not affect the Nitrogen content. The diagram of the activator treatment content is shown in Figure 2.

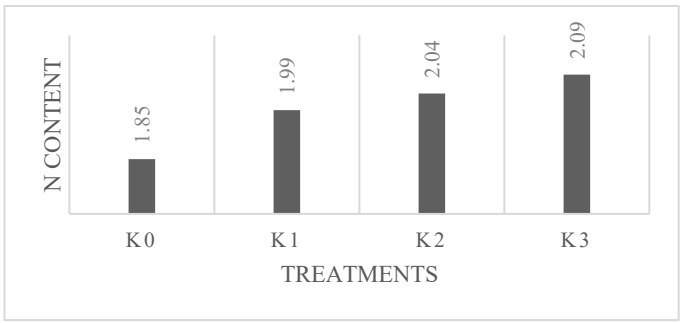

Figure 2. Influence Probio FM and Starbo AFE against Nitrogen content in compost water hyacinth

The total N element in compost is obtained from the degradation of organic materials by microorganisms. The source of nitrogen is protein, which is first decomposed by microorganisms into amino acids, a process known as amino acid formation [13]. During composting, the N element is used for maintenance and the composition of microorganism cells. The higher the nitrogen content, the faster the organic material decomposes. The total N content based on the table above for K3, K2, K1, and K0 is 2.09, 2.04, 1.99, and 1.85, respectively.

The highest N content is found in K3 compost. In composting hospital organic waste, it was found that compost without the addition of activator had a higher total N content (1.3%) compared to compost with the addition of activator (0.9%) [14]. In addition, the results of research [15] on sheep faeces, composting showed that the average total N was higher in compost

without the addition of activator compared to compost with activator.

The use of activators in composting increases the levels of macronutrients (N, P, K) compared to compost without activators. Activators accelerate the decomposition of organic materials, making nutrients more available and optimal for plant growth.

3.3. Phosphorus (P) content

The phosphorus content was analyzed after the compost had been left to compost for 30 days. Following the analysis of the observed variables, various treatments were applied. It was found that Probio FM and Starbo AFE did not have any impact on the phosphorus content. Figure 3 presents a diagram illustrating the effects of the different activator treatments.

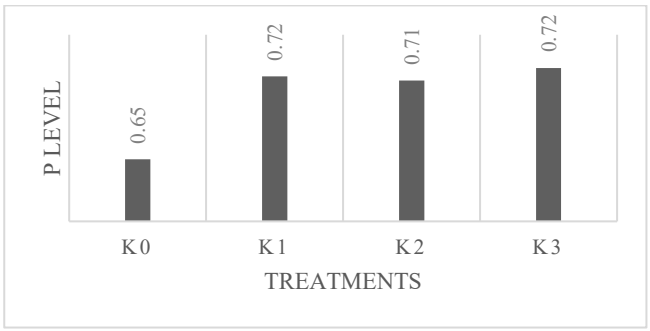

Figure 3. Influence Probio FM and Starbo AFE against the level of Phosphorus in compost water hyacinth

Total P elements are elements that are difficult to dissolve but are also essential for microorganisms to synthesise nucleic acids. The availability of organic phosphorus (P) for plants is highly dependent on microbial activity for its mineralisation. [16] States that the content (P_2O_5) depends on the N content in the compost. The greater the nitrogen content, the greater the multiplication of microorganisms that break down phosphorus, resulting in an increase in phosphorus content in the compost material. The figure indicates that the phosphorus concentrations in K3, K2, K1, and K0 were 0.72, 0.71, 0.72, and 0.65, respectively.

The compost with the same value as K3 and K1 exhibited the highest P content. The highest P content was observed in compost without the addition of activators, as indicated by the findings of research [15] on municipal waste decomposition. The compost with the same value as K3 and K1 exhibited the highest P content. The highest P content was observed in the compost without the addition of activators, as indicated by research findings [15] on the decomposition of municipal waste. The P content of K3, K2, and K1 composts is not significantly different, as evidenced by the image above. The study's findings [14] indicated that there was no discernible distinction between decomposition that contained and did not contain activators. Water hyacinth compost (K2, K1, and K0) has met the minimal phosphorus content of 0.10% mandated by SNI, as indicated by the study's findings.

3.4. Potassium (K) content

The potassium content was assessed after 30 days of composting. Based on the analysis of the observed factors, various therapies were administered. Probio FM and Starbo AFE did not influence the potassium content. Figure 4 illustrates the content diagram of the activator treatment. Figure 4 illustrates the content diagram of the activator treatment.

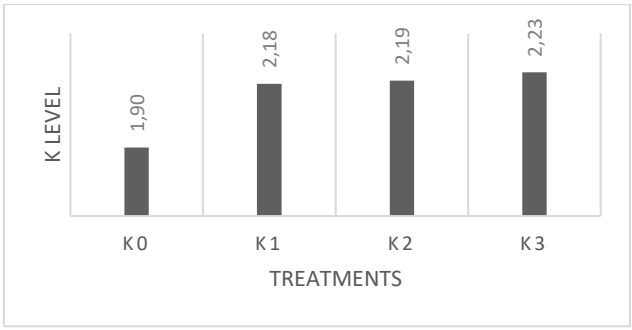

Figure 4. Influence Probio FM and Starbo AFE against Potassium content in compost water hyacinth

During decomposition, the K element in complex organic compounds is transformed into simple organic K in the form of K+. Phosphate-solubilizing bacteria may often solubilize potassium elements in organic substrates. Potassium in compost raw materials plays a role in microbial metabolism and acts as a catalyst [17]. The diagram above indicates that the K values for K3, K2, K1, and K0 are 2.23, 2.19, 2.18, and 1.90, respectively.

The maximum potassium content was achieved in K3 compost. Research findings [8] indicate that the potassium level after 40 days of rice straw composting in compost lacking biodecomposers was superior to that in compost including biodecomposers. The table indicates that the potassium amount in the K_2, K1, and K0 composts is nearly the same, likely due to the K_2O content originating from organic components rich in greens. The potassium concentration of water hyacinth compost from this study, across all treatments, aligns with SNI standards, where green materials exhibit high levels of K_2O.

3.5. Aroma

Evaluation of compost aroma conducted by eight panellists utilizing olfactory perception. The compost that is not yet fully matured retains a fresh scent reminiscent of the original materials, whilst a soil-like aroma indicates that the compost is nearing maturity. The test results are displayed in the table below.

The table indicates that the aroma for K2 is less pungent, K3 and K1 are non-pungent, while K0 is pungent. The odor test is conducted by assessing the aroma or scent released during the decomposition process. The persistent foul odor emanating from the compost signifies a continued high infection of pathogenic bacteria, particularly Escherichia coli and Salmonella spp. These two microorganisms typically originate from organic waste mixed with human or

animal excrement and can persist if the decomposition process has not occurred optimally. The elevated levels of E. coli and Salmonella suggest that the compost is immature, and unhygienic.

Table 1. Compost Odor Assessment Utilizing Probio FM and Strabo AFE Activators

Treatment	evaluation		
	I	II	III
K0	+	+	+
K1	+++	+++	+++
K2	++	++	++
K3	+++	+++	+++

The table indicates that the aroma of K2 is less pungent, while K3 and K1 are non-pungent, and K0 is pungent. The odor test is conducted by assessing the aroma or scent released during the decomposition process. The persistent foul odour emanating from the compost indicates a continued high level of pathogenic bacteria, particularly Escherichia coli and Salmonella spp. These two microorganisms typically originate from organic waste mixed with human or animal excrement and can persist if the decomposition process has not occurred optimally. The elevated levels of E. coli and Salmonella suggest that the compost is immature and unhygienic.

4. Conclusion

The overall composition of the body, with the inclusion of the activators Probio MN and Starbo AFE, exhibits high quality, characterized by a non-pungent odor and a fine texture. The C-organic levels that comply with RSNI3 7763:2024 are derived from composted water hyacinth with additives. Nitrogen and potassium levels are ranked second, while phosphorus remains low. The composting process lasts 30 days, utilizing water hyacinth and incorporating cow rumen starter.

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