STORAGE TIME AND MIXING TECHNIQUE EFFECT ON THE NUTRIENT CONTENT OF BIOPOS COMPOST

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ABSTRACT

SEAMEO BIOTROP produces daily waste from oyster mushroom baglog (*Pleurotus ostreatus*), dry organic waste that contains little water, such as dry leaves, grass straw, and citronella distilled waste. Managing oyster mushroom baglog waste, leaf waste, grass straw, and citronella distilled waste independently at SEAMEO BIOTROP as organic compost BIOPOS (BIOTROP Compost) is an environmentally friendly practice and can provide benefits both economically and ecologically. Apart from being carried out to protect biodiversity from decline, this study can also keep the soil system healthy and sustainable. The aims of this research are to: (1) make BIOPOS organic compost through the use of oyster mushroom baglog, leaf waste, leaf straw, and citronella distilled waste; (2) determine the influence of various types of BIOPOS organic compost (KT1, KT2, KT3) on the chemical content of compost. Research stages include: (1) creating BIOPOS organic compost, (2) measuring the chemical content of BIOPOS organic compost, and (3) measuring the effectiveness of BIOPOS. During the storage period of 30 days after mixing the materials (dam) up to 180 dam, BIOPOS organic compost which still contains Nitrogen (N) (0.54%), Phosphor (P) (36.8%), Potassium (K) (7.23%) and complies with Indonesian National Standard (SNI) 19-7030-2004 quality standards is KT3. In measuring C-Organic value, BIOPOS code KT2 with a storage period of 30 dam gained C-Organic amount of 28.36%, satisfying quality standards. The application of BIOPOS KT1, KT2, and KT3 with a pH range of 8.2- 8.3 high pH can be used to correct problems that often occur in acidic soils and is not effective when applied to sub-optimal alkaline soils because it will cause soil pH to increase sharply.

Keywords: BIOPOS, citronella distilled waste, grass straw, leaf waste, oyster mushroom baglog waste

INTRODUCTION

Waste is something that is not used, is not liked, or must be thrown away, which usually comes from human actions after using natural products. SEAMEO BIOTROP produces daily waste from oyster mushroom baglog (*Pleurotus ostreatus*), dry organic waste that contains little water, such as dry leaves, grass straw, and citronella distilled waste. The waste produced is directly proportional to the vegetation zone of the SEAMEO BIOTROP area. SEAMEO BIOTROP is a regional research center with a total area of around 12 hectares and a vegetation zone consisting of 4.5 hectares of secondary forest, 2 hectares of experimental gardens, and 5.5 hectares of plantation forest.

Organic waste comes from the remains of living creatures (nature) such as animals, humans, plants, and processed objects that can experience decay or weathering. The process of decomposing or weathering organic waste occurs naturally with the help of microorganisms without adding chemicals in a short time. Currently, solid waste management is a hot topic for discussion. Various countries are trying to find methods to replace conventional landfilling and land burning. The best solution to this problem is to convert waste into organic compost or biological fertilizer, which is useful for the environment, especially for plant growth, and increases soil fertility and health. The best way to maintain a healthy and sustainable soil system is through integrated nutrient management involving biofertilizers and organic compost. One of the best technologies for more sustainable waste processing is compost. Composting has been used as a recycling method for solid organic materials for decades because it can improve soil fertility and structure and maintain soil water content (Maindargikar, 2022).

According to Pakpahan et al. (2024), when applied as compost, the main component is dry leaf detritus. Detritus is fragments (ruin) of dead organisms (animals and plants) and remains of organisms such as animal waste, leaves, and fallen twigs, which are broken down by decomposers. Apart from that, another alternative for making organic compost is by utilizing baglog mushroom waste (Ayu, 2021). Cultivating white oyster mushrooms requires a medium for growing, namely using a baglog. In a medium-scale cultivation group, the edible mushroom house can produce up to 1 to 2 tons of baglog waste per year (Putri, 2022). This mushroom-growing medium has a lifespan, and when its usage is over, it will become waste and reduce the valuable value of the baglog. This waste is often not recycled, only thrown away straight away or even burned until the combustion residue pollutes the surrounding air. The high nutritional content, such as organic Carbon (C) (49%), total Nitrogen (N) (0.6%), Potassium (K) (0.02%), and Phosphor (P) (0.7%), gives these wastes the potential to be recycled into organic compost (Fatmawati et al., 2023).

Managing oyster mushroom baglog waste, leaf waste, grass straw, and citronella distilled waste independently at SEAMEO BIOTROP as organic compost BIOPOS (BIOTROP Compost) is an environmentally friendly practice and can provide benefits both economically and ecologically. Apart from being carried out to protect biodiversity from decline, this study can also keep the soil system healthy and sustainable. This research aims to (1) make BIOPOS organic compost through the use of oyster mushroom baglog, leaf waste, and citronella distilled waste; (2) determine the influence of various types of BIOPOS organic compost (KT1, KT2, KT3) on the chemical content of compost.

METHOD

The research was carried out for 7 months, from 6th of September 2023 up to 6th of March 2024, in the Biosystems Landscape and Management (BLM) laboratory, Service Laboratory, phytopathology laboratory, and greenhouse of SEAMEO BIOTROP, Bogor, Indonesia. Research stages included (1) creating BIOPOS organic compost, (2) measuring the chemical content of BIOPOS organic compost, and (3) measuring the effectiveness of BIOPOS. The stage of creating BIOPOS organic compost was carried out by mixing mushroom baglog waste (1.75 kg), dry leaves (0.5 kg), grass straw (0.25 kg), and citronella (0.25 g), bran (0.25 kg), and $CaCO_3$ (5 g) which had been prepared and chopped then weighed up to 3 kg. The bioactivator formula (a mixture of EM4 and molasses) was homogenized according to the specified dosage. After that, around 1-2 kg of teak forest soil (fertile soil) was added to the sack, 300 kg of charcoal then the mixture was covered with 300 kg of teak forest soil. The sack was tightly tied and incubated. the temperature was regularly checked for twice a day to ensure that the compost temperature had increased to ±50 ^{o}C and was not contaminated. After incubation for ±4 days, then the compost was sieved and divided it into 3 types, namely unshifted (BIOPOS KT1), after sieved and separated from the leaf litter (BIOPOS KT2), and after sifted and leaving leaf litter (BIOPOS KT3) (Figure 1).

Figure 1. Organic compost from left to right: BIOPOS KT1 (prepared without sifting), KT2 (after sifting and separating from leaf litter) and KT3 (after sifting and leaving leaf litter) before storage

Afterwards, the compost was wrapped in the Ziplock plastic and stored for 30 and 180 days after mixing the materials (dam). At the stage of measuring the chemical content of BIOPOS organic compost, the parameters observed include pH, C-Organic, N-total, C/N ratio, P-total and K-total. The pH parameters were analyzed after the composting stage was completed using the method according to the SEAMEO BIOTROP Service Laboratory work instructions SL-MU-TT-02; BIOPOS C-organic parameters were measured using the Walkley and Black Method according to the SEAMEO BIOTROP Service Laboratory work instructions SL-MU-TT-03; N-total parameters were measured using the Kjeldahl method (SL-MU-TT-04); the C/N ratio parameter is the total comparison between organic C and total N; P-total parameters in K_2O_5 are measured according to the SEAMEO BIOTROP Service Laboratory work instructions SL-MU-TT-06; and the K-total parameter in K_2O was analyzed using the Atomic Absorption Spectrophotometry (AAS) method referring to the SEAMEO BIOTROP Service Laboratory work instructions SL-MU-TT-08. BIOPOS effectiveness is measured by comparing the results of measuring the chemical content of BIOPOS with organic compost quality standards according to Indonesian National Standard (SNI) 19-7030-2004.

RESULTS AND DISCUSSION

Based on the results of measuring the chemical content of three types of BIOPOS organic compost (KT1, KT2, and KT3), the following data was obtained (Table 1.)

Table 1. Results of measuring the chemical content of the three types of BIOPOS organic compost (KT1, KT2, and KT3)

Storage Time (days)	Analysis Parameters	Results of Chemical Measurements of BIOPOS Content			Organic Compost Quality Standards According to SNI 19-7030-2004	
		KT1	KT2	KT3	Min	Max
30	pH	8,2	8,3	8,2	6,8	7,49
	C-organic (%)	38,94	28,36	39,87	9,8	32
	N-total (%)	0,99	0,84	1,07	0,4	-
	C/N ratio	39	34	37	10	20
	P-total (%)	0,27	0,25	0,24	0,1	-
	K-total (%)	3,85	4,85	3,54	0,2	*
180	pH	8,3	8,3	8,3	6,8	7,49
	C-organic (%)	2,15	1,06	1,96	9,8	32
	N-total (%)	0,31	0,32	0,54	0,4	-
	C/N ratio	7	3,3	3,62	10	20
	P-total (%)	22,2	40	36,8	0,1	-
	K-total (%)	5,9	5,64	7,23	0,2	*

* the value is greater than the minimum or smaller than the maximum.

The analysis results shown in Table 1 states that the pH of BIOPOS KT1, KT2, and KT3 shows no change in pH value; the pH ranges between 8.2 – 8.3 even after being stored for 30 and 180 dam. This value is indicated as a pH, which is classified as alkaline. Based on SNI 19-7030-2004 concerning Specifications for Compost from Domestic Organic Waste, it is stated that the standard for the pH of compost from domestic organic waste is in the range of 6.8 – 7.4.Thus, it can be concluded that the BIOPOS samples KT1, KT2, and KT3 did not meet the quality standards determined by SNI 19-7030-2004. In its application, BIOPOS, with a pH range of 8.2 – 8.3, was not effective for application on the sub-optimal alkaline land because this pH range could cause the soil pH to increase sharply. As a result, the increase in pH has adverse effects on the soil, including disrupting the availability of macro and micronutrients and disrupting the balance of microorganisms in the soil, and high pH can result in soil dispersion (Kavitha & Arjunan, 2020).

Meanwhile, Yuwono (2007) stated that compost will become mature when organic acids become neutral during the composting process with a mature compost pH range of 6-8. The advantages of composting with a high pH can improve problems that often occurs in acid soil. South Kalimantan is an area that is known to have quite an extensive acid land, both dry land and wetland. It is beneficial if baglog oyster mushroom waste compost which has a high pH is applied to the land, it will help overcome the acidity of the soil. Saputra and Sari (2021) reported that peat and tidal soils given ameliorant, which has an alkaline pH, can increase the pH of the soil. Ameliorants with a high/alkaline pH contain Ca and Mg, which can replace the position of H+ on the colloid surface so that soil acidity becomes neutral (Jumar et al., 2021).

Analysis of C-Organic content in BIOPOS code KT2 with a storage period of 30 dam met the criteria with a C-Organic value of 28.36% because it was still below the quality requirements of SNI 19-7030-2004 (the highest value is 32%). Meanwhile, BIOPOS codes KT1 and KT3 (38.94%; 39.87%) with a storage period of 30 dam produced organic C levels above 32%. This is in contrast to what was stored for 180 dam; the C-Organic content decreased drastically, being below the minimum required value (9.8%), namely 2.15%; 1.06; and 1.96%. The length of compost storage affects the levels of C-Organic. C-Organic is used by decomposing bacteria as an energy source. Dewilda et.al., (2019) reported that differences in organic C values in compost were influenced by the length of the composting process. It is recommended that the compost storage time be less than 180 dam so that C-Organic levels do not decrease. This is because solid organic C is used by decomposing bacteria as an energy source in metabolic processes and cell division, which is converted into CO_2, NH_3, and H_2O both aerobically and anaerobically.

During the storage period of 30 dam, the results of compost nutrient analysis (total N content) in BIOPOS with codes KT1, KT2, and KT3, each amounted to 0.99%; 0.84%; and 1.07% met quality standards (>0.4%). However, during the storage period of 180 dam the N-total content of BIOPOS KT1 and KT2 was 0.31% and 0.32% below the quality standard. However, according to literature standards, level of N total in organic compost ranges from 1.5% - 2.5% is preferably (Nopsagiarti, 2020). Storage time affects the N total content of a compost. To maintain the levels of N levels and improve the quality criteria, organic compost needs to contain nitrogen-fixing and ammonia-oxidizing bacteria so that the nitrogen content in the compost does not decrease.

On the other hand, during the storage period of 30 dam, the C/N ratio of BIOPOS KT1, KT2, KT3 (39; 34; 37) did not meet the quality standard because the C/N ratio was more than 20 (the largest value of the required C/N ratio quality standard). Meanwhile, at a storage time of 180 dam, the C/N ratio of BIOPOS KT1, KT2, KT3 decreased drastically (7; 3.3; 3.62) to less than 10 (the smallest value of the required C/N ratio quality standard). The C/N ratio is the ratio of the microbial energy supply used to nitrogen for protein synthesis. Compost N-total content is the factor that most influences the C/N ratio of compost (Harahap et al., 2015).

In connection with the compost nutrient analysis content of Potassium (K_2O) and Phosphorus (P_2O_5) levels, the overall mixing technique treatment (KT 1, KT2, KT3) with storage time settings of 30 and 180 dam was able to increase the percentage of P-total and K-total so that it remained above the quality standards required by SNI 19-7030-2004. The storage time of BIOPOS is directly proportional to the percent levels of P-total and K-total. It is suspected that BIOPOS KT1, KT2, and KT3 contain phosphorus and potassium for solubilizing microorganisms. With the addition of phosphorus and potassium solvent microorganisms, the quality of the compost will increase (Kilo et al., 2023). The increase in potassium levels is caused by the activity of microorganisms that decompose organic matter. The variation in potassium content values is partly due to differences in the speed of microorganisms in carrying out the decomposition process of organic material during fermentation (Mulyadi & Yovina, 2013). The potassium level in BIOPOS, which was made from mushroom baglog waste, can be concluded to be high. Judging from the period after treatment, the nutrient content of potassium could increase over time. Organic acids produced from bacterial metabolic activity cause macronutrients such as K to have high solubility (Huy, 2020). Bacteria require K^+ cation intake in their metabolic processes so that K element levels can be influenced by the age of the compost (Lin, 2022). Dried leaves and sawdust, which were the main ingredients of BIOPOS, have an important role in contributing to the K element. Contributing the K element can provide soil resistance and make it easier for plant roots to absorb it.

Potassium has an important role in the photosynthesis process in the formation of protein and cellulose, which functions to strengthen plant stems (Ekawandani & Kusuma, 2018). Symptoms of potassium deficiency in plants will cause brown leaf edges. The potassium element binder comes from the decomposition of organic materials by microorganisms in piles of compost material (Trivana & Pradhana, 2017). Compost material, which is a fresh organic material, contains potassium in a complex organic form that cannot be used directly by plants for their growth. Decomposition activities by microorganisms change organics. The element phosphorus (P) is an organic material that has a vital role in soil fertility, photosynthesis processes, and the chemical physiology of plants. Phosphorus is also needed in cell division, tissue development, and plant growth points (Widarti et al., 2015). Symptoms of a lack of P levels in plants are significantly reduced root growth, old leaves turning yellow prematurely, and stunted plants.

CONCLUSION

During the storage period of 30 dam up to 180 dam, BIOPOS organic compost which still contains N (0.54%), P (36.8%), K (7.23%) and complies with SNI 19-7030-2004 quality standards is KT3. In measuring C-Organic value, BIOPOS code KT2 with a storage period of 30 dam gained C-Organic amount of 28.36%, satisfying quality standards. The application of BIOPOS KT1, KT2, and KT3 with a pH range of 8.2 - 8.3. A high pH can be used to correct problems that often occur in acidic soils and is not effective when applied to sub-optimal alkaline soils because it will cause soil pH to increase sharply.

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