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THE EFFECT OF BOKASHI AND THEIR INCUBATION PERIOD ON SOME CHEMICAL PROPERTIES OF ULTISOLS

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ABSTRACT

The objectives of the research were: to determine some of the chemical properties of bokashi (swiftletpoop, banana peels, and tea dregs) and to determine the effect of giving different types of bokashi and their incubation time on some of the chemical properties of Ultisols soil.
This research was conducted from February – to March 2021 in the Jl. Talang Sari. Samarinda. East Kalimantan and analysis of bokashi fertilizer and soil was carried out at the Soil Laboratory, Faculty of Agriculture, Mulawarman University, Samarinda.
The research treatments consisted of: without giving bokashi (p0), giving swiftletpoop bokashi (p1), giving banana peel bokashi (p2), and giving tea dregs bokashi (p3) where each bokashi type treatment was incubated for 2 weeks and 4 weeks. .

The research activities included: (1) making swiftletpoop bokashi, banana peel bokashi, and tea dregs bokashi, (2) Ultisol soil media preparation and treatment of bokashi types (swiftletpoop bokashi, banana peel waste, and tea dregs waste) and incubation for 2 and 4 weeks, (3) analysis of some chemical properties of bokashi fertilizer, and (4) analysis of soil after incubation for each type of bokashi fertilizer treatment.

The results showed that: (1) bokashi fertilizer incubated for 4 weeks in Ultisols soil resulted in higher soil pH, C-organic content, N-total, available P and available K and higher C/N ratio compared to the incubation period. for 2 weeks; (2) Application of bokashi fertilizer on Ultisols soil increased soil pH, C-organic content, N-total, available P and available K and C/N ratio of Ultisols soil compared to no bokashi fertilizer; and (3) Application of bokashi fertilizer with swiftletpoop resulted in the highest total organic C and N, application of banana peel bokashi fertilizer resulted in the highest soil pH and available P, while tea dregs bokashi application resulted in the highest C/N ratio.

KEYWORDS

Chemical Properties, Bokashi Fertilizer, Ultisols.

INTRODUCTION

The main program in agricultural development in Indonesia which is the mainstay of national development is to improve food security and agribusiness development. To support these efforts, Indonesia has a very large land potential that can be cultivated, namely in the form of irrigated land, swamp land and dry land.

The development of farming on dry land faces many obstacles due to low soil fertility, so it cannot be planted without prior amelioration treatment. Soil improvements that are often carried out include liming, adding N, P, and K fertilizers and micro elements.

The use of artificial/inorganic fertilizers is a farming activity that is always carried out, even most farmers consider it a must. No fertilization or too little fertilizer applied often results in low yields.

One effort to overcome dependence on the use of inorganic fertilizers is the provision of organic matter or organic fertilizers. The addition of organic matter is expected to improve the physical properties of the soil such as structure, porosity and the ability of the soil to hold water. In addition, organic matter can also act as a source of nutrients and improve other soil chemical properties such as pH, CEC and base saturation.

Bokashi is a fertilizer made by fermenting organic materials usually using effective microorganism-4 (EM-4). EM-4 is a bacterial decomposer to destroy organic matter so that the material can be applied as organic fertilizer. EM-4 is a mixed inoculum of materials containing photosynthetic, yeast, Lactobacillus, Actinomycetes and fermented fungi. These materials can synergize with each other to improve soil quality and increase crop production (Birnadi, 2014). There are several types of materials that can be used for making bokashi, namely, manure, straw, charcoal, bird droppings and others (Wididana, 1996).

Swiftletpoop are often considered waste and have not been used by breeders. Swiftletpoop contain 50.46% C-Organic compounds; 11.24% total N, C/N ratio 4.49% with pH 7.97, 1.59% P; 2.17% K; 0.30% Ca; and 0.01% Mg (Sutanto, 2002), by minimizing the waste of swiftletpoop, it can be made into bokashi which contains a lot of organic matter so that it can add nutrients to the soil (Talino, 2013).

Banana peel is a waste material (banana fruit waste) which is quite a lot, which is about 1/3 of unpeeled bananas. Until now, banana peels have not been widely used, only disposed of as organic waste or used as fodder for goats, cows, and buffalo. A large number of banana peels will have a profitable selling value if they can be used as raw materials for the manufacture of organic fertilizers (Susanti, 2006).

Tea is a very popular drink. Tea has a good taste and smells good, besides that tea can warm the body or can be consumed cold. After consumption, the tea dregs are usually thrown away. But actually tea dregs can be used as organic fertilizer that can improve soil fertility, tea dregs can be used directly without being processed again. Tea powder, either in the form of tea bags (tea packs must be opened) or leaf tea, can be a good source of fertilizer for soil and plants, tea dregs fertilizer cannot be absorbed directly but will provide nutrients through the decomposition process (Hidayat, 2013).

MATERIALS AND METHODS

A. Time and Place

This research was conducted from February – March 2021 in the Jl. Talang Sari. Samarinda, East Kalimantan. Analysis of bokashi fertilizer and soil was carried out at the Soil Laboratory, Faculty of Agriculture, Mulawarman University, Samarinda.

B. Materials and Tools

The materials used in this study were soil media from Ultisols, swiftlet droppings, banana peels, tea dregs, bran, husks, EM4, soil, and water. While the tools used are hoes, buckets, polybags, sacks, tarpaulins, knives, machetes, meters, documentation tools, stationery, calculating tools and scales.

C. Treatment Design

The research treatments consisted of: without giving bokashi (p_0), giving wallet bird droppings bokashi (p_1), giving banana peel bokashi (p_2), giving tea dregs bokashi (p_3) where each bokashi type treatment was incubated for 2 weeks and 4 weeks.

D. Research Procedure

Research activities include:

1. Making wallet bird droppings bokashi, banana peel bokashi, and tea dregs bokashi
2. Preparation of Ultisol soil media and treatment with bokashi (swallow droppings, banana peel waste, and tea dregs) and incubation for 2 and 4 weeks.
3. Analysis of some chemical properties of bokashi fertilizer
4. Soil analysis after incubation for each type of bokashi fertilizer treatment.

E. Data Collection

The data collected include: (1) analysis of initial soil chemical properties (pH, organic C, total N, C/N ratio, available P, and available K); (2) analysis of the chemical properties of each bokashi (pH, C-organic, total N, C/N ratio, available P, and available K); and (3) analysis of soil chemical properties after application of bokashi types (pH, C-organic, total N, C/N ratio, available P, and available K).

F. Data Analysis

Soil data from laboratory analysis was analyzed descriptively by comparing the soil from the laboratory with the criteria for assessing soil chemical properties based on BPT Bogor (2005). The data on the chemical properties of all bokashi were analyzed based on the criteria for the quality standard of organic fertilizers developed by the Ministry of Agriculture and Trade Market (2006).

RESULTS AND DISCUSSION

A. Results of Analysis of Bokashi Fertilizers

The results of the laboratory analysis of various bokashi fertilizers are presented in Table 1 below:

Table 1. Laboratory Analysis Results of Various Bokashi Fertilizers

Kind ofBokashi	pH	C organik (%)	N total (%)	C/N Rasio	P Total (%)	K Total (%)
SwiftletPoop	6,35	24,05	0,66	36,39	6,32	3,35
Banana peel	8,16	21,96	0,50	43,58	0.66	1,00
Tea dregs	6,57	18,66	0,43	43,28	5,13	4,84

Source: Soil Science Laboratory, Faculty of Agriculture, Mulawarman University (2021)

Based on Table 1 above, it shows that the chemical properties of types of bokashi are as follows: (1) swiftletbokashi has a pH = 6.35; 24.05% C-organic; 0.66% of total N; C/N ratio = 36.39; 6.32% P total; and 3.35% K total; (2) banana peel bokashi has a pH = 8.16; 21.96% C-organic; 0.50% of total N; C/N ratio = 43.58; 0.66% of total P; and 1.00% K total; and (3) tea dregs bokashi has a pH = 6.57; 18.66% C-organic; 0.43% of total N; C/N ratio = 43.28; 5.13% of total P; and 4.84% K total. In general, it shows that swiftletbokashi contains higher organic C, total N and total P and is easier to decompose than banana peel bokashi and tea dregsbokashi.

B. The Effect of Bokashi Fertilizer and Incubation Time on Some Chemical Properties of Ultisols

The results of soil analysis after application of various kinds of bokashi fertilizer that have been incubated for 2 and 4 weeks are presented in Table 2 and Table 3 below:

Table 2. Soil Analysis Results (pH, C-Organic and C/N Ratio) After Application of Various Bokashi Fertilizers

Bokashi treatment	Soil pH		C-Organik(%)		C/N Rasio	
	2 MSI	4 MSI	2 MSI	4 MSI	2 MSI	4 MSI
NoBokashiapplication (p_0)	4,10 (SM)	4,30 (SM)	2,20 (R)	0.82 (SR)	10.99 (S)	2,52 (SR)
B. made from swiftletpoop (p_1)	4,16 (SM)	4,86 (SM)	2,92 (S)	5,01 (T)	8,29 (R)	7,93 (R)
B. made from banana peel (p_2)	4,64 (SM)	5,06 (M)	2,77 (S)	3,59 (T)	16,95 (T)	7,09 (R)
B. made from tea dregs (p_3)	4,66 (SM)	4,99 (SM)	2,99 (S)	4,75 (T)	9,64 (R)	11,73 (S)

Source: Soil Science Laboratory, Faculty of Agriculture, Mulawarman University (2021)

Description: Weeks After Incubation; SM = very acid; M = acid;
SR = very low; R = low; S= moderate; T = high.

1. Soil pH

Based on the results of the analysis (Table 1) shows that the pH value of the soil after 2 weeks of incubation, namely: 4.10 (without giving bokashi); 4.16 (swallow droppings bokashi treatment); 4.64 (banana peel bokashi treatment) and 4.66 (tea pulp bokashi treatment); while the pH of the soil after 4 weeks of incubation, namely: 4.30 (without giving bokashi); 4.86 (swallow droppings bokashi treatment); 5,06 (banana peel bokashi treatment) and 4,99 (tea pulp bokashi treatment); while the soil pH after 4 weeks of incubation. In general, it showed that there was an increase in the pH value of the soil from an incubation period of 2 weeks to an incubation period of 4 weeks. This is due to the decomposition process of bokashi fertilizer added to the soil. Organic compounds derived from bokashi fertilizer can react with Al cations to form Al chelate compounds so that it can reduce Al solubility and increase pH with the addition of organic matter (Arif, 2012). This is also supported by the statement of Bohn, et al. (2004) that chelate compounds can reduce the active Al and H-dd fractions in the soil so that their solubility is reduced. In addition to overhauling the bokashi fertilizer, it produces alkaline cations that can increase soil pH.

2. C-Organic

Based on the results of the analysis (Table 1) showed that the C-organic content of the soil after 2 weeks of incubation, namely: 2.20% (without giving bokashi); 2,92% (swiftletpoop bokashi treatment); 2.77% (banana peel bokashi treatment) and 2.99% (tea dregsbokashi treatment); while the C-organic content after 4 weeks of incubation, namely: 0.82% (without giving bokashi); 5.01% (swiftletpoop bokashi treatment); 3.59% (banana peel bokashi treatment) and 4.75% (tea dregsbokashi treatment). In general, it shows that the treatment of various kinds of bokashi causes an increase in the organic C content from an incubation period of 2 weeks to an incubation period of 4 weeks. This is because bokashi fertilizer is an organic fertilizer which is mostly composed of C-organic compounds (Table 1).According to Djunaedy (2009) that the addition of organic matter (such as bokashi) into the soil can increase the organic matter content of the soil.

On the other hand, the treatment without bokashi showed a decrease in the C-organic content. This was because there was no addition of organic matter and the existing soil organic matter was reshuffled into simple compounds. In the decomposition process, organic matter is broken down into inorganic compounds so that organic C levels decrease (Sukarwati, 2011).

3. C/N Ratio

Based on the results of the analysis (Table 1) showed that the C/N ratio of the soil after 2 weeks of incubation, namely: 10.99 (without giving bokashi); 8.29 (swiftletpoopbokashi treatment); 16.95 (banana peel

bokashi treatment) and 9.64 (tea pulp bokashi treatment); while the content of C/N ratio after 4 weeks of incubation, namely: 2.52 (without giving bokashi); 7.93 (swiftletpoop bokashi treatment); 7.09 (banana peel bokashi treatment) and 11.73 (tea pulp bokashi treatment). In general, it shows that in the treatment without bokashi, swiftletpoopbokashi treatment and banana peel bokashi treatment there is a decrease in the value of the C/N ratio, while in the tea pulp bokashi treatment there is an increase in the value of the C/N ratio. All values of the C/N ratio are classified as moderate to very low. Rao (1994) stated that the optimum level of N ratio ranged from 20-25. The decrease in the C/N ratio was due to the bokashi fertilizer of swiftletpoop and banana peels containing higher total N than the tea dregs bokashi fertilizer (Table 2), thus affecting the C/N ratio. The results showed that the longer the incubation period of bokashi fertilizer was followed by a decrease in the C/N ratio. It was stated by Hakim et al (1986) that when the value of the C/N ratio is less than 20, then there has been a release of N from organic matter due to the decomposition process. Furthermore, it was stated by Gao et al., (2012) that bokashi is the result of fermentation of organic matter using EM-4. Added by Wididana (1996), EM-4 contains microorganisms that decompose organic matter. Djuranani N, Kristian, and Setiawan (2005) stated that the principle of composting is to reduce the C/N ratio of organic matter to the same as the soil C/N ratio.

Table 3. Soil Analysis Results (Total N, Available P and K Available) After Giving Various Kinds of Bokashi Fertilizer

Bokashi treatment	N Total (%)		P Available (ppm)		K Available (ppm)	
	2 MSI	4 MSI	2 MSI	4 MSI	2 MSI	4 MSI
NoBokashiapplication (p0)	0,20 (R)	0,32 (S)	84,48 (ST)	84,91 (ST)	153,41 (ST)	154,23 (ST)
B. made from swiftletpoop (p_1)	0,36 (S)	0,66 (T)	158,83 (ST)	197,74 (ST)	223,34 (ST)	332,28 (ST)
B. made from banana peel (p_2)	0,19 (R)	0,51 (T)	173,39 (ST)	207,09 (ST)	276,18 (ST)	344,87 (ST)
B. made from tea dregs (p_3)	0,30 (S)	0,41 (S)	153,18 (ST)	189,48 (ST)	190,72 (ST)	284,72 (ST)

Source: Laboratory of Soil Science, Faculty of Agriculture, Mulawarman University (2021)

Description: Weeks After Incubation; R = low; S= moderate; T = high;
ST = very high

4. N-total

Based on the results of the analysis (Table 2) showed that the N-total content of the soil after 2 weeks of incubation, namely: 0.20% (without giving bokashi); 0.36% (swiftletpoopbokashi treatment); 0.19% (banana peel bokashi treatment) and 0.30% (tea pulp bokashi treatment); while the total N content after 4 weeks of incubation was: 0.32% (without bokashi); 0.66% (swallow droppings bokashi treatment); 0.51% (banana peel bokashi treatment) and 0.41% (tea pulp bokashi treatment). In general, it showed that in the treatment of various kinds of bokashi there was an increase in the total N content from the incubation period of 2 weeks to the incubation period of 4 weeks, and also the treatment without bokashi showed an increase in the total N content. This shows that the application of the three kinds of bokashi fertilizer on the soil has a good effect on the availability of N. The total N content of the soil describes the organic and inorganic N content. (Munawar, 2011).Furthermore, Winarso (2005) stated that the process of mineralization of N in the soil is largely determined by the activity of soil microorganisms (fungi, bacteria, actinomycetes and so on). The speed of mineralization is not only determined by the number and types of microorganisms in the soil, but also by the types of materials and environmental conditions.

5. P-Available

Based on the results of the analysis (Table 2) showed that the available P content of the soil after 2 weeks of incubation, namely: 84.48 ppm (without giving bokashi); 158.83 ppm (swiftletpoopbokashi treatment); 173.39 ppm (banana peel bokashi treatment) and 153.18 ppm (tea pulp bokashi treatment); while the P content available after 4 weeks of incubation, namely: 84.91 ppm (without bokashi); 197.74 ppm (swiftletpoopbokashi treatment); 207.09 ppm (banana peel bokashi treatment) and 189.48 ppm (tea pulp bokashi treatment). In

general, it was shown that in the treatment of various kinds of bokashi there was an increase in the available P content from an incubation period of 2 weeks to an incubation period of 4 weeks, and also the treatment without bokashi showed an increase in the available P content. The increase in available P in the soil was closely related to the increase in soil pH and organic matter content (Table 1). Winarso (2005) stated that at low pH, soluble P will react with soluble Fe and Al and its hydroxides to form relatively insoluble Fe-P and Al-P compounds. P adsorption by Fe and Al cations can decrease with increasing soil pH. Furthermore, Munawar (2011) stated that organic matter (such as bokashi fertilizer) can affect P fixation, thereby preventing P adsorption by Fe and Al cations. In addition, the overhaul of organic matter produces organic acids such as oxalic and citric, the anions of these organic acids can reduce P adsorption and increase P availability.

6. K-Available

Based on the results of the analysis (Table 2) showed that the K content available in the soil after 2 weeks of incubation, namely: 153.41 ppm (without giving bokashi); 223.34 ppm (swiftletpoopbokashi treatment); 276.09 ppm (banana peel bokashi treatment) and 189.48 ppm (tea pulp bokashi treatment); while the content of K available after 4 weeks of incubation, namely: 154.23 ppm (without giving bokashi); 332.28 ppm (swiftletpoopbokashi treatment); 344.87 ppm (banana peel bokashi treatment) and 284.72 ppm (tea pulp bokashi treatment). In general, it showed that in the treatment of various kinds of bokashi there was an increase in the available K content from an incubation period of 2 weeks to an incubation period of 4 weeks, and whereas in the treatment without bokashi, the available K content tended to not change significantly. There was an increase in available K with the application of various types of bokashi and the longer incubation period was associated with an improvement in soil pH and an increase in cation exchange capacity by organic matter. Poerwodidodo (2002) stated that several factors that influence the availability of K are soil mineralogy, organic matter content, CEC, soil pH, aeration, and soil density. Munawar (2011) states that the effect of pH on the availability of K is not direct, it is also stated in soils with a high CEC, most of the K is available to plants in the form of exchangeable K.

CONCLUSIONS AND SUGGESTIONS

A. Conclusion

1. Bokashi fertilizer incubated for 4 weeks in Ultisols soil resulted in higher soil pH, C-organic content, N-total, available P and available K and a lower C/N ratio than the incubation period of 2 weeks.
2. Giving bokashi fertilizer to Ultisols soil increased soil pH, C-organic content, N-total, available P and available K and C/N ratio of Ultisols soil compared to no bokashi fertilizer.
3. The application of bokashi fertilizer with swallow droppings produced the highest total organic C and N, application of banana peel bokashi fertilizer resulted in the highest soil pH and available P, while the application of tea dregs bokashi produced the highest C/N ratio.

B. Suggestion

1. It is necessary to conduct a similar study with a longer incubation period and a wider variety of organic materials such as organic waste from markets and households,
2. Observations should be completed on the physical, chemical and biological properties of the soil.

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