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Quality of Organic Fertilizer Due to Material Combination with Bio-activator

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ABSTRACT
Litters or pine cage mats are very good at absorbing water and odours from broiler chicken manure. Pine-based litter takes a long time to decompose. Therefore, this study was conducted to find out how the waste was processed into compost using a combination of materials and levels of EM-4 bioactivator. This study used litters of chicken, pine wood waste and water hyacinth with the addition of a different EM-4 bioactivator. The research design used was a completely randomized factorial design (CRFD) consisting of 2 treatment factors with 3 replications. Treatment A was a combination of ingredients used: A0= 100% litter of chicken; A1= 70% litters of chicken, 15% pine sawdust, 15% water hyacinth; A2 = 55% litter of chicken, 30% pine sawdust, 15% water hyacinth; A3=40% litter chicken, 45% pine sawdust 15% water hyacinth. Treatment B level of bioactivator: B1=1% and B2=2%. The parameters observed were pH (degree of acidity), humidity, temperature, and C/N ratio in organic fertilizers. The data obtained were analyzed using Analysis of Variance (ANOVA) and if the results of the analysis showed an effect, it was continued with the Duncan Multiple Range Test. The results showed that Factor A in the treatment had a significant effect on the degree of acidity (pH), humidity and temperature, but had no effect on the parameters of the C/N ratio at 6 weeks of composting. Factor B did not show any effect on all parameters at the same composting time. The conclusion is that the combination treatment of materials and bioactivator levels has not been able to reduce the C/N ratio with a composting time of 6 weeks, so it is recommended to use a longer time.

Keywords: *Pinus, Waste, Organic, Fertilizer, Bioactivator.*

1. INTRODUCTION

Livestock waste in the form of untreated litter has caused major problems and has a negative effect on the environment, as well as directly disrupting the cleanliness and health of the community around the cage. Without special handling, waste or garbage causes major problems for the community [1]. However, the type of organic waste originating from plant waste and livestock business waste is a material that has the potential to be utilized.

Improper handling of chicken liters can lead to the proliferation of pathogenic microorganisms and disease vector organisms such as flies [2]. Therefore, special processing is needed using a compost starter (inoculant) and the right mixture of materials. Another material that has the potential to become waste in the surrounding environment is water hyacinth. Water hyacinth plants so far are only considered aquatic weeds whose presence can interfere with activities in water areas because their growth is very fast. Therefore, it is necessary to take action to overcome these problems by processing water hyacinth combined with pine waste and liters of chicken into organic fertilizer. To speed up the process of making organic fertilizers, it is necessary to add inoculants or starters that contain active and anaerobic bacteria. Different types of inoculants are expected to affect the quality of the manure produced. Currently, the types of inoculants that are often used vary from effective microorganisms consisting of *Lactobacillus casei*, *Saccharomyces cerevisiae*, and *Rhodopseudomonas palustris.*

Based on the description above, it is very necessary to do research related to the utilization of chicken litters, pine sawdust waste, water hyacinth with the addition of different inoculants to the quality of organic fertilizers, water hyacinth so that it can be used as land and plant fertilizer.

2. MATERIALS AND METHODS

The materials used in this study were liters of chicken, waste pine sawdust, and water hyacinth as well as EM-4 bioactivator with two different levels of 1% and 2%. The organic fertilizer storage process lasts for 6 weeks. The tools used in this study were shovels, digital scales, white plastic, takemura soil tester, plugged in thermometer, spray bottle, gloves, masks, stationery and cameras.

The design used in this study was a Factorial Completely Randomized Design (RALF) consisting of 2 treatment factors, factor A combination of ingredients (A0 = 100% liters of chicken, A1 = 70% liters of chicken, 15% pine wood powder, 15% water hyacinth, A2= 55% liter of chicken, 30% of pine wood powder, 15% of water hyacinth, A3= 40% liter of chicken, 45% of pine wood powder, 15% of water hyacinth) and factor B percentage of EM-4 inoculants with the amount of 1% and 2 % of the total compost material, each treatment was repeated 3 times. The parameters that will be observed from this research are pH (degree of acidity), humidity, temperature, and C/N. The data obtained were analyzed using Analysis of Variance (ANOVA) and if the results of the analysis showed an effect on the treatment, it was continued with the Duncan Multiple Range Test (DMRT) [3].

The preparation of this research begins with the collection of composting materials such as litters of chicken, pine sawdust waste, and water hyacinth. The research was carried out by mixing all the ingredients and adding EM-4 as a bioactivator, the ingredients were stirred evenly. Then the pH (degree of acidity), temperature, and C/N measurements were taken at the initial stage. After that, the compost is put in a silo and stored for 6 weeks. Checking pH (degree of acidity), temperature and C/N was carried out again at the end of the 6th week of the study.

3. RESULTS AND DISCUSSION

3.1 Degree of acidity (pH) of organic fertilizer

The average degree of acidity of organic fertilizer combination of litters of chicken mixed media, pine sawdust waste, water hyacinth waste is given different levels of bioactivator EM-4 at week 0 and week 6 can be seen in Table 1. The degree of acidity in the composting process plays an important role in the activity of the microorganisms present in it.

Table 1. The average degree of acidity (pH) of organic fertilizer at week 0

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	5.03±1.34	4.53±1.44	4.78
A1	6.00±0.20	4.30±1.14	5.15
A2	4.73±0.46	4.33±0.76	4.53
A3	5.47±0.31	5.73±0.12	5.60
Average	5.31	4.725	

Note: Different superscripts in the same row and column show no significant effect (P>0.05) on the degree of acidity (pH) of organic fertilizers.

Table 2. The average degree of acidity (pH) of organic fertilizer at week 6.

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	5.10±0.96	4.83±1.37	4.97[a]
A1	4.53±0.50	3.60±0.17	4.07[b]
A2	3.60±0.17	3.80±0.26	3.70[b]
A3	4.67±0.61	4.43±0.40	4.55[ab]
Average	4.48	4.17	

Note: Different superscripts in the same row and column show a significant effect (P<0.05) on the degree of acidity (pH) of organic fertilizers.

Table 3. The average humidity of organic fertilizer at week 0

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	65.00±30.41	76.67±31.75	70.83
A1	44.33±4.04	81.67±27.54	63.00
A2	65.00±8.66	77.67±18.61	71.33
A3	53.33±5.03	48.67±1.15	51.00
Average	56.92	71.17	

Note: Different superscripts in the same row and column show no significant effect (P>0.05) on the degree of the humidity of organic fertilizer

Table 4. The average humidity of organic fertilizer at week 6.

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	59.67±17.79	65.00±30.81	62.33^{c}
A1	69.33±10.07	96.67±5.77	83.00ab
A2	96.67±5.77	89.33±10.07	93.00^{a}
A3	67.67±11.24	71.67±7.64	69.67^{b}
Average	73.33	80.67	

Note: Different superscripts in the same row and column show a significant effect (P<0.05) on the degree of humidity of organic fertilizer.

Table 5. The average temperature of organic fertilizer at week 0.

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	$42.70{\pm}0.10^{a}$	$42.53{\pm}0.40^{a}$	42.62^{a}
A1	$42.00{\pm}0.79^{a}$	$38.37{\pm}1.24^{bc}$	40.18^{b}
A2	$38.57{\pm}1.38^{b}$	$41.07{\pm}1.23^{a}$	39.82^{b}
A3	$36.40{\pm}1.25^{c}$	$37.00{\pm}1.81^{bc}$	37.10^{c}

Note: Different superscripts in the same row and column show significant effect (P<0.05) on the degree temperature of organic fertilizer.

Table 6. The average temperature of organic fertilizer at week 6

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	$28.00{\pm}0.35^{b}$	$27.97{\pm}0.12^{b}$	27.98^{b}
A1	$28.07{\pm}0.06^{b}$	$27.93{\pm}0.15^{b}$	28.00^{b}
A2	$28.03{\pm}0.12^{b}$	$28.53{\pm}0.32^{a}$	28.28^{a}
A3	$28.47{\pm}0.06^{a}$	$28.20{\pm}0.10^{ab}$	28.33^{a}
Average	28.14^{a}	28.16^{a}	

Note: Different superscripts in the same row and column show significant effect (P<0.05) on the degree temperature of organic fertilizer

The initial acidity in the compost should be 6.5 – 6.7 so that the decomposing microbes can cooperate with the decomposing microorganisms. If the composted organic matter is too acidic, it can be increased by adding lime. At the beginning of composting, the degree of acidity becomes acidic because organic matter is decomposed into organic acids, but the longer the degree of acidity returns to neutral [4].

Based on the results of analysis of variance in Table 1, it shows that factor A and factor B at week 0 have no significant effect on the degree of acidity, it can be seen from the table which shows that the compost is in an acidic state, this is in accordance with the opinion of Yaman [1] which stated at the beginning of composting pH will become acidic because organic matter is decomposed into organic acids, but the longer the curing time the pH will return to neutral. According to Supadma and Arthagama [5] the pattern of changes in the pH of the compost starts from a slightly acidic pH ranging from 5-6 due to the formation of simple organic acids, then the pH increases on further incubation due to the breakdown of protein and release of ammonia. Increasing and decreasing pH is also a marker of the activity of microorganisms in the decomposing organic matter [6]. Changes in pH also indicate the activity of microorganisms in degrading organic matter [7].

At week 6, the combination of organic fertilizer with liters of chicken mixed media, pine sawdust waste, water hyacinth waste is given different levels of bioactivator EM-4 showed a significant effect ($P<0.05$) between treatments on the degree of acidity (pH). The control treatment (A0) had the highest pH value of 4.97 which was almost the same as the treatment (A3) which was 4.55. In factors (A1) and (A2) there was a decrease in pH to 4.07 and 3.70. The decrease in pH of organic fertilizer in this study could be caused by the long storage time in the composting process. This is in accordance with Wahyono's statement [8] which states that the compost produced under acidic conditions tends to be immature.

The Center for Environmental Education [9] stated that composting tusam wood (*Pinus merkusii*) sawdust and rubber wood sawdust (*Hevea braziliensis*) using EM-4 activator and manure produced compost that was ready for use within 4 months. Where should the optimum pH for composting be between 6.6-7.5 which is neutral [10] meets the standard criteria as stated in SNI 19-7030-2004 [11]. According to Marlina [12], the pH of organic fertilizer materials is acidic at the beginning of composting because acid-forming bacteria will lower the pH so that organic fertilizers are more acidic. Furthermore, microorganisms begin to convert inorganic nitrogen into ammonia so that the pH increases rapidly to become alkaline. Some of the ammonia is released or converted to nitrate and nitrate is denitrified by bacteria so that the pH of the compost becomes neutral. The original nature of the soil is acidic so that a neutral pH is useful for reducing acidity and making it easier for plants to absorb [13].

3.2 Organic Fertilizer Moisture

The average humidity of organic fertilizer combined with litres of chicken mixed media, pine sawdust waste, water hyacinth waste given different levels of bioactivator EM-4 at week 0 and week 6 can be seen in Table 3 and Table 4. One of the factors that affect composting is humidity. Moisture plays an important role in microbial metabolism and indirectly affects oxygen supply. Microorganisms can take advantage of organic matter if the organic material is soluble in water.

Based on the results of the variance in Table 4, it shows that the humidity of organic fertilizers has no significant effect ($P <0.05$) it can be seen from the average humidity that does not match the optimum range, according to Mulyono's statement [4] stating good humidity in organic fertilizers. Ranged from 40-60%, but in the treatment of A1B1, A3B1 and A3B2, which ranged from 44.33 to 53.33% were included in the optimum humidity category.

In table 4, it can be seen that the humidity at week 6 in factor A had a significant effect ($P<0.05$) on humidity but this average was not in accordance with the optimum humidity, which was around 40-60%, while the average humidity at week 6 was 62.33-93.00%. Humidity greater than 60% causes nutrients to be washed out and air volume decreases, as a result, microbial activity will decrease and an-aerobic fermentation will occur which causes an unpleasant odor [4]. Humidity at week 6 which corresponds to the optimum humidity only occurs in treatment A0B1 (control) which is made from 100% liter chicken + 1% EM-4, according to Hanafiah [14], low humidity, fungi and bacteria can work more actively. According to Juanda *et al*. [15], if the compost pile is too moist, the decomposition process will be hampered. This is because the water content will cover the air cavity in the pile. So that humidity greatly affects the development of microbes. While the higher water content in organic fertilizers can be reduced by the drying process [16].

In this study, the humidity has not reached the optimum humidity according to SNI 19-7030-2004 [11]. This is because the research time is 6 weeks, so the water hyacinth waste is still not dry or decomposed. For this reason, a longer curing time is needed so that the organic matter decomposes completely because pine powder has a rough and hard physical structure.

3.3 Organic Fertilizer Temperature

The average temperature of organic fertilizer with a combination of litters of chicken mixed media, pine sawdust waste, water hyacinth waste is given different levels of bioactivator EM-4 at week 0 and week 6 can be seen in Table 8 and Table 9. Temperature is one of the most important things. It is important to control for the needs of microorganisms to decompose, the optimum temperature is in the range of 30 - 40ºC. If the temperature is too low or too high, the bacteria in the compost will die [4].

The analysis of variance above, it shows that there is an interaction between AxB factors affecting the temperature of organic fertilizer, it can be seen from the average temperature table 0 ranging from 37º-42.70ºC.

Figure 1 showed that the combination of ingredients, the lower liter composition of chicken and the higher pine sawdust showed a very significant effect on lowering the temperature of week 0 organic fertilizer. Meanwhile, in a study conducted by Hajama [17] with the title study of utilization water hyacinth as a compost material using EM-4 activator at the beginning of composting until the 30th day ranging from 26.4-37.9ºC. The temperature in the study was lower in the research that had been done, this was due

Table 7. Average C/N of organic fertilizer at week 0.

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	16.15±0.10^{h}	16.80±0.01^{g}	16.47^{d}
A1	23.95±0.03^{e}	17.70±0.03^{f}	20.82^{c}
A2	37.92±0.02^{d}	41.35±0.03^{b}	39.63^{b}
A3	39.34±0.02^{c}	64.92±0.01^{a}	52.13^{a}
Average	29.34^{b}	35.19^{a}	

Note: Different superscripts in the same row and column showed a very significant effect on (P<0.01) on C/N of organic fertilizer.

Table 8. Average C/N of organic fertilizer at week 6.

Combination of ingredients (A)	Level EM4 (B)		Average
	1%	2%	
A0	26.01±0.03	22.49±0.04	24.25
A1	30.25±0.01	28.95±0.04	24.56
A2	23.18±0.03	26.17±0.02	24.68
A3	23.78±0.02	23.65±0.02	23.72
Average	23.29	25.32	

Note: Different superscripts in the same row and column showed a very significant effect on (P<0.01) on C/N of organic fertilizer

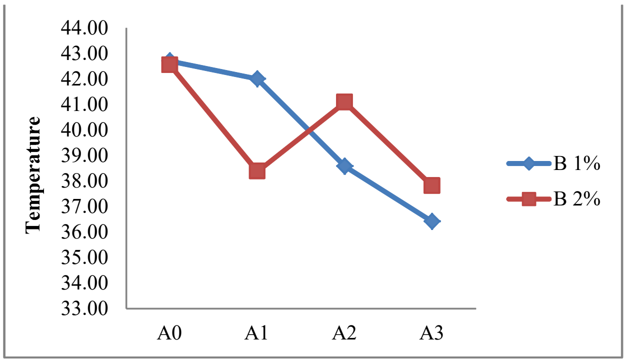

Figure 1. Week 0 temperature A*B interaction graph

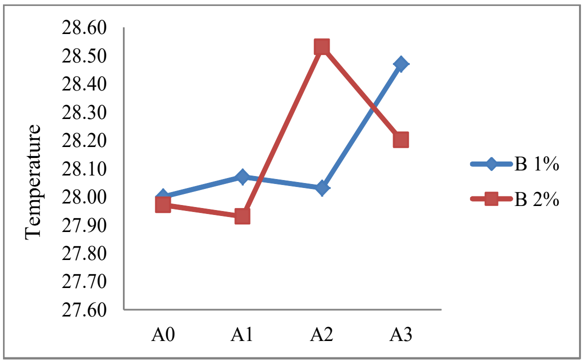

Figure 2. Week 6 temperature A*B interaction graph

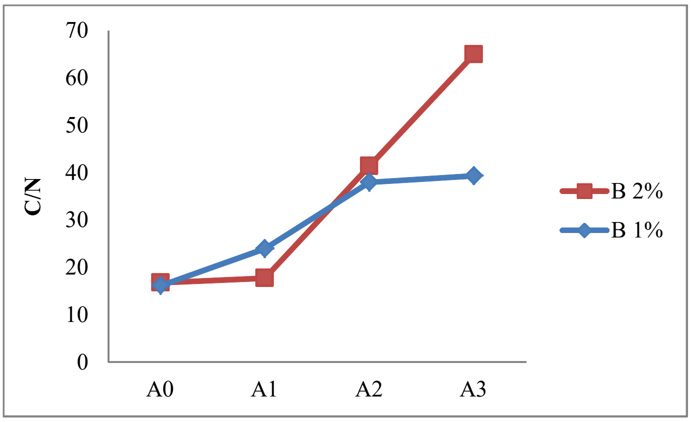

Figure 3. Graph of the interaction of A*B factors on C/N week 0

to the addition of a combination of ingredients, namely liters of chicken and pine sawdust.

At week 6 the average temperature decreased from week 0 it can be said that this is a temperature that is not ideal for organic fertilizers, this could also be due to the absence of microbial activity working on fertilizers. Mulyono [4] also stated that if the temperature is too low or too high, the bacteria in the compost will die. The low temperature of the compost is thought to be due to the insufficient amount of waste in the composting process to provide heat insulation [18].

In this study, the temperature was not in accordance with SNI 19-7030-2004 [11]. From the beginning to the middle of the composting process, thermophilic microorganisms will be present and play a role in the degradation process of organic matter. Thermophilic microorganisms can live in the temperature range of 45º-60ºC. These microorganisms consume carbohydrates and protein as organic fertilizer ingredients. The temperature gradually decreases due to reduced organic matter that can be decomposed by microorganisms. When temperature conditions decrease, mesophilic microorganisms develop to replace thermophilic microorganisms. Temperature affects the types of microorganisms that live in the media. Ruskandi [19] stated that the process of making organic fertilizers is very dependent on the amount and type of organic matter used and the treatment given from preparation to the ripening process.

3.4 C/N Ratio of Organic Fertilizer

The average ratio of C/N ratio values of organic fertilizer mixed media liters of chicken, pine sawdust waste, water hyacinth waste is given different levels of EM-4 bioactivator at week 0 and week 6 can be seen in Table 10 and Table 11. False One of the most important aspects of total nutrient balance is the ratio of organic carbon to nitrogen (C/N). According to Hidayati *et al*. [20] carbon is used as a source of energy and nitrogen as a source of nutrients for the formation of body cells of microorganisms during the composting process.

In the first week, the average yield experienced an interaction between the AxB factors, which showed a very significant effect on the C/N of the compost. The interaction graph can be seen in Figure 3. This is because in the first week the results of the analysis listed are the results of the C/N ratio of organic matter from a combination of ingredients for making organic fertilizers, these materials are still intact and no decomposition has occurred. This is in accordance with the statement of Djuranani *et al.* [21] that the principle of composting is to reduce the C/N ratio of organic matter to the same as the soil C/N ratio.

In the treatment A0B1 (16.15), A0B2 (16.80) and A1B2 (17.70) had reached the soil C/N ratio in the early weeks, this may be due to the liter of chicken that was taken indirectly, it had undergone aerobic decomposition by experienced before. The effective C/N ratio for the composting process ranges from 30-40. Microorganisms break down C compounds as an energy source and use N for protein synthesis. If the C/N is too high, the microbes will lack N for protein synthesis so that the decomposition runs more slowly [22].

At week 6 both the material combination factor and the EM4 level factor did not affect the value of the C/N ratio of compost, good compost had a C/N ratio value close to the content of the soil C/N ratio value of 10-20 according to the SNI 19-7030-2004 standard. [11], while in this study the C/N ranged from 22.49 – 30.25. This shows that the different combinations of liters of chicken, pine sawdust, and water hyacinth with bioactivator levels affect the C/N ratio of organic fertilizers. The varied content of microorganisms in probiotics in this study did not affect the value of the C/N ratio in fertilizers. According to Djuranani *et al* [21], high C/N will reduce the activity of microorganisms. In addition, several cycles of microorganisms are needed to complete the degradation of the compost material so that the composting time will be longer and the compost produced is of low quality.

In this study, the C/N ratio has not reached the range stated in SNI 19-70302004 [11]. The higher the C/N ratio in the compost indicates the compost has not decomposed completely or has not yet matured [23]. Mature compost has a C/N ratio of less than 20. If the C/N ratio is higher, then the compost is not yet ripe and requires a longer decomposition time [22]. Although water hyacinth contains nutrients needed by plants, its fiber content and high C/N ratio make the composting process take longer than other plants [24]. At the value of the C/N ratio ranging from 30-40, then the compost has a C/N ratio value above 20 which means that the nutrients in the organic waste have not been decomposed and mineralized so they are less available and interfere with their application by plant roots [14]. The high organic matter content in fresh water hyacinth and pine sawdust requires a curing time that is longer than 6 weeks.

4. CONCLUSION

Through research, it is known that the combination of litters of chicken, waste pine sawdust and water hyacinth as raw materials for organic fertilizer requires a longer ripening period because the pine powder used is still fresh so it takes a longer time to reach the C/N ratio as in SNI 19-70302004.

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