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"Effective Microorganism" Test from Tomato and Chicken Intestine as the Starter in Making Biological Organic Fertilizer

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Abstract
Biological organic fertilizer was a fertilizer that was made from organic materials (plant, cattle dung, etc.) with a help from Effective Microorganism (EM) as the biodecomposer with simple technology that could use local material, cheap material, and easily in producing. This research was an experimental research in field, which was researching the effectiveness of EM from tomato and the content of chicken intestine as the starter in the process of making biological organic fertilizer. The design of this research was true experiment with the form of Pretest-Posttest in control group design by involving >1 independent variables. This research utilized 3 variances of EM materials, which were 1 lt EM of tomato, 1 lt EM of chicken intestine and mixture between ½ lt EM of tomato and ½ lt EM of chicken intestine. Each variance would be mixed by 10 kg of fertilizer material (6 kg of cattle dung, 1 kg of bran and 3 charcoal husks). Each of the materials was replicated 3 (three) times. The result of this research utilized SNI/2004 standard, which was: pH, temperature, humidity, water level, odor, color, texture, chemical parameters (C,N,K,P,C/N), and long maturation. The result of measurement and observation was it had become a fertilizer in control sample, EM of tomato, EM of chicken intestine, and the synergic EM between EM of tomato and EM of the intestine, which each of them had pH (6.9; 7; 7; 7), temperature (31.9; 33.8; 35.4;35.5), humidity (40; 39.8; 44.8; 43.7), chemical parameter C (21.7; 18.7; 18.4; 21.9),N (1.4; 1.3;1.2; 1.2), K (2.3; 2.4;1.55;1.8), P (0.8; 1.1;0.9;1.0), C/N (15.3; 14.5; 15.3; 18.3), odor, color, texture, and qualified the requirement of SNI/2004 standard. Moreover, the best result of the fermentation by using either synergic intestine or tomato in 5 weeks of compost maturation time was the EM of tomato and intestine needed 6 weeks, meanwhile, the control group in 8 weeks had not matured. Therefore, either tomato or chicken intestine could be used as the starter in making organic fertilizer by farmer.
Keywords: *Effectiveness of microorganism, Chicken Intestine and Tomato, Organic Fertilizer*

1.0 INTRODUCTION

The process of making organic fertilizer by using Effective microorganism (EM) was biodecomposer that was used more in the process of making compost, became briefer, easy, and had better quality. Effective microorganism could be processed by self from chicken intestine and tomato fruit which were sold to be easily found and to have cheap price. This research aimed at analyzing the effective microorganism from tomato fruit and chicken intestine which were the starter in making biological organic fertilizer.

2.0 METHODS

The design of this true experiment research was pretest-posttest with control group. The basic material of this organic fertilizer was charcoal husk, bran, and cattle dung. The experiment of group A used EM from tomato fruit, group B used EM from chicken intestine, and group C from synergic tomato and chicken intestine. Meanwhile, the control group did not use any EM. Each sample was given treatment in three times of replication. The process of making EM was molasses in 2,5 kg and 5 liters of water were boiled until being cooked and then, chilled it. The formula for A with EM of 2 kg tomato, which was blended, was entered into the liquid. Afterwards, it was fermented for 8-12 days. In formula B, it was added 1 kg of the content of chicken intestine, and also synergic tomato and chicken intestine which the comparison between them was 1:1.

The process of making organic fertilizer used cattle dung (6 kg), charcoal husk (3 kg), and bran (1 kg) by adding EM of tomato (treatment A), chicken intestine (treatment B) and EM of chicken intestine (treatment C), which each of them was 1 liter. For the control group (treatment D), it did not use any EM above. The measured parameters were temperature, pH, humidity, odor, color, texture, unsure of N, P, K, C, C/N ratio, and the long of maturation process. The result of organic fertilizer used measurement standard of SNI/2004. The research location was in the Department of Environmental Health in Madiun, in Environmental Health major, Health Polytechnic of Surabaya Ministry of Health, Jl. Tri Pandita No. 6, Magetan, East Java, Indonesia.

3.0 RESULTS

Table 1: The Result of the Measurement of temperature, humidity, and pH

Code	Parameter	Replication in									Mean
			1	2	3	4	5	30	30	30	
B	Temperature	1	34	39	40	39	31	30	30	30	34.1
		2	33	34	39	37	32	34	30	30	33.1
		3	32	34	36	38	33	7	6.8	6.8	33.4
	pH	1	7	6.8	7	7	7	7	6.8	7	6.9
		2	6.8	7	7	7	7	7	7	6.8	7.0
		3	7	7	6.8	7	7	45	45	44	7.0
	Humidity	1	46	45	47	40	45	47	45	47	44.6
		2	45	47	45	45	45	40	47	40	45.8
		3	43	45	47	45	47	33	32	31	44.3
B EM of Chicken intestine	Temperature	1	33	33	35	40	37	36	32	30	34.3
		2	32	36	36	38	40	35	32	30	35.0
		3	32	33	34	37	38	7	6.8	6.8	33.9
	pH	1	6.8	7	7	7	7	7	6.8	7	6.9
		2	6.8	6.8	7	7	7	7	7	7	6.9
		3	7	7	6.8		7	45	44	44	7.0
	Humidity	1	49	49	47	47	45	45	45	44	46.3
		2	48	48	47	47	45	45	44	44	46.1
		3	45	44	44	44	43				44.1
C EM of tomato	Temperature	1	32	32	35	35	39	36	33	31	34.1
		2	30	32	35	36	38	39	33	30	34.1
		3	32	33	35	35	37	39	33	31	34.4
	pH	1	7		7	7	7	6.8	7	7	7.0
		2	6.8	7	7	7	7	6.8	7	7	7.0
		3	6.8	7	7	7	7	7	6.5	7	6.9
	Humidity	1	37	37	40	40	38	38	38	43	38.9
		2	36	39	38	38	37	37	40	40	38.1
		3	37	43	43	42	42	40	40	43	41.3
D Control	Temperature	1	30	30	32	37	37	35	33	33	33.4
		2	31	31	32	38	36	33	35	33	33.6
		3	30	32	33	37	33	36	32	33	33.3
	pH	1	8	7	8	8	7	7	7	7	7.4
		2	7,5	7	8	8	7	7	7	7	7.3
		3	7	7	6.8	7	7	7	7	6.8	7.0
	Humidity	1	40	40	38	38	38	43	43	42	40.3
		2	42	42	40	40	40	39	39	39	40.1
		3	40	38	38	38	43	43	40	39	39.9

Table 2: The Result of the Measurement of Color, Odor, and Texture

Code		Repli-cation	Week in									Note
			0	1	2	3	4	5	6	7	8	
A EM of Chicken Intestine and EM of Tomato	COLOR	1	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Blackish	Blackish	Blackish	Blackish	SNI 19-7030-2004 Color: Blackish Odor: Smelling of Soil Texture: Soft
		2	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Blackish	Blackish	Blackish	Blackish	
		3	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Blackish	Blackish	Blackish	Blackish	
	ODOR	1	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	

Code		Repli-cation	Week in									Note
			0	1	2	3	4	5	6	7	8	
		2	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	
		3	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	
	TEXTURE	1	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		2	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		3	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
B EM of Chicken Intestine	COLOR	1	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Blackish	Blackish	SNI 19-7030-2004 Color : Blackish Odor: Smelling of Soil Texture: Soft
		2	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Blackish	Blackish	
		3	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Blackish	Blackish	
	ODOR	1	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	
		2	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	
		3	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	Smelling of Soil	
	TEXTURE	1	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		2	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		3	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
C EM Of Tomato	COLOR	1	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Blackish	Dark Brown	Dark Brown	Blackish	Blackish	
		2	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Blackish	Dark Brown	Dark Brown	Blackish	Blackish	
		3	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Blackish	Dark Brown	Dark Brown	Blackish	Blackish	
	ODOR	1	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	Smelling of Soil	Smelling as its basic material	A little smelling of soil	Smelling as its basic material	A little smelling of soil	SNI 19-7030-2004 Color : Blackish Odor : Smelling of Soil Texture : Soft
		2	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	
		3	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	A little smelling of soil	A little smelling of soil	A little smelling of soil	Smelling of Soil	Smelling of Soil	
	TEXTURE	1	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		2	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		3	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
D Control	COLOR	1	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	SNI 19-7030-2004 Color : Blackish Odor : Smelling of Soil Texture : Soft
		2	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	
		3	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	Dark Brown	
	ODOR	1	Smelling as its	Smelling as its	Smelling as its	Smelling as its	Smelling as its	Smelling as its	Smelling as its	Smelling as its	A little smelling of soil	

Code		Repli-cation	Week in 0	1	2	3	4	5	6	7	8	Note
			basic material	basic material	basic material	basic material	basic material	basic material	basic material	basic material		
		2	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	
		3	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	Smelling as its basic material	A little smelling of soil	
	TEXTURE	1	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		2	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	
		3	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	Soft	

Table 3: The Result of Laboratory Test of Nitrogen, Phosphor, Calium, and C

No	CODE	C.Org	B O	N	P_2O_5	K_2O	C/N
		Walkley & Black		Kjeldhal	Destruction of HNO_3 and $HClO_4$		Calculation
1	A	20.73	35.74	1.33	0.82	2.12	15.59
2	AA	20.73	35.74	1.4	0.82	2.45	14.81
3	AAA	23.69	40.85	1.54	0.73	2.49	15.38
4	B	15.16	26.13	1.19	0.9	2.06	12.74
5	BB	19.51	33.64	1.26	1.14	2.45	15.48
6	BBB	21.43	36.94	1.4	1.21	2.69	15.3
7	C	17.59	30.33	1.16	0.88	1.55	15.17
8	CC	18.47	31.84	1.19	0.84	1.61	15.52
9	CCC	19.34	33.34	1.26	0.83	1.51	15.35
10	D	20.03	34.54	1.05	0.84	2	19.08
11	DD	22.12	38.14	1.19	0.96	1.86	18.59
12	DDD	23.69	40.85	1.37	1.15	1.6	17.29

4.0 DISCUSSION

Temperature: From the observation result of biological organic fertilizer, it was occurred a temperature change gradually in first week because it underwent masophilic phase (warmth) which the microorganism was present in biological organic fertilizer that decomposed the size of biological organic fertilizer until the climax in third weeks until fourth weeks. After that, it was occurred the temperature reduction gradually and stably in fifth weeks. Moreover, temperature was an indicator that was used for knowing the decomposition process of organic materials. According to Sidharta (2013), the increase or decrease of temperature indicated that the activity of microorganism also increased and decreased in decomposing organic garbage. Treatment A in fifth weeks had been closer to the soil temperature, which was 31℃ and it meant that it was closer to mature compost. The height of compost material pile that was over thin (15) did not enable to be reached thermophilic phase because the material will be more quickly in losing the heat (Budi, *et. al*. 2015). The high temperature in the process of composing was very important for killing pathogen bacteria and weed seeds. Either high or low temperature while making biological organic fertilizer, it was influenced by the factor of unstable weather, the process of waste reversal that was less evenly and less controlled. The process of mature compost that was indicated by the decrease of temperature, which was close to soil temperature (30℃) and had physical change to be blackish, was decomposed as soil grain and it did not smell which was in accordance with SNI 19-7030-2004.

pH: It was occurred pH change from beginning until the end of composting. In control group, it was occurred the increase of pH and being stable in neutral pH in seventh weeks. The increase of pH was due to the lack of microorganism that demolished the compost material. Either the increase or the decrease of pH indicated that there was decomposing activity of organic material by microorganism (Firdaus, 2011). The increase of pH was due to the activity of microorganism that gave an input of OH^- ion from the result of decomposing process of compost material (Manurung, 2011). pH value in observation tended to undergo an increase which was caused by base cations contribution as the result of mineralization of compost material, such as K^{2+}, Ca^{2+} and Mg^{2+}, and also as the consequence of protein destroying, ammonia evaporation, and activity of microorganism in splitting organic nitrogen and sulfate reduction (Permana, 2011).

Humidity: The humidity was very important in metabolism process of microbe and indirectly, it influenced on oxygen needs. In process of making biological organic fertilizer in aerobe, the aeration was much needed so that the aerobic bacteria could be still alive. Generally, good humidity in the process of making biological organic fertilizer was depended on kinds of organic materials which were used in the mixture of biological organic fertilizer materials (Indriani, 2010). It was obtained that the humidity from each treatment A, B, C, D was around 40-45%. Microbe activity would undergo a reduction and if it was occurred a humidity under 40%, it would be lower again in the humidity 15% (Isroi, 2008)

***Color**:* The compost would become blackish color in fifth weeks which was in treatment A in seventh weeks on the addition of EM of intestine and EM of tomato. Meanwhile, in control group until eighth weeks, it had not been a blackish color. The slow process of composting in control group was due to the lack of microorganism activity. There was a color change in compost which was done by microorganism with help of quite oxygen, hence, it could isolate the heat (Musnawar, 2003).

***Odor**:* The odor lessened in fourth group which was in treatment A, in sixth weeks and seventh weeks for treatment B and C; and in eighth weeks for control group. This was caused by there was a decomposer that could ferment organic materials which was in the materials by releasing the fermentation result, such as sugar, alcohol, vitamin, lactate acid, amino acid and other organic chemical compounds (Aminah and Suparti, 2005). Fermentation of organic material released heat and gas that smelled bad, thus, the result of fermentation of organic material created good condition for microorganism growth. The more number the microorganism, the better it was, because it related with the quick time of decomposition. According to Permana and Hirasmawan (2008), compost that had been mature, it smelled as soil because the contained materials had resembled the material of soil and it had dark brown color that was formed as the impact of the influence of stable organic materials.

Texture: From the observation result, the making process of decomposed biological organic fertilizer as the grain of soil was occurred in first week from all treatments because all of the materials were milled softly. The biological organic fertilizer that was resulted had soft texture because in the process of making the biological organic fertilizer, it had been done a refinement of basic material first so that it would be easier to be decomposed by microorganism. According to Yuli Priyanto (2010), the smaller the particle size of organic material, the larger the surface that could be attacked by microorganism. However, too small size would hinder the water movement into biological organic fertilizer pile and CO_2 movement went out. It meant that a treatment that used either EM of tomato or EM of intestine and synergic both of them had similar maturation of the texture as long with the form of the color and odor above. It meant that the materials of biological organic fertilizer had been degraded nutrient (N, P and K). Thus, on that time, the color of biological organic fertilizer changed into blackish. Besides, the biological organic fertilizer did not smell again and its texture had shown grain as the soil (Anif and Harismah, 2004). Physical change in biological organic fertilizer was occurred as long as other parameter changes during the process of composting. The change of color, texture, and odor in biological organic fertilizer was caused by the contained material that had resembled soil material and had blackish color which was formed as the impact of organic material decomposing that was occurred naturally by life microorganism in biological organic fertilizer materials. According to SNI 19-7030-2004, good compost that was ready to be used must qualify the standard of blackish color, smelling of soil, and having texture as the soil.

4.1 The Result of Laboratory Test of Nitrogen, Phospor, Potassium and C.

Nitrogen: Content of the highest nitrogen in treatment A was 1.42%, followed by treatment B in 1.20% and C, D in 1.20%. The content of N in third treatments was higher from minimum level based on SNI 19-7030-2004 which was in 0.4%. The ability of microorganism that was in treatment A was quicker in degrading the material of biological organic fertilizer rather than the treatment B, C, and D. This was caused by the process of decomposition by microorganism that resulted ammonia. The N was trapped into compost pile due to very small follicle of compost pile, thus, the ammonia and nitrogen which were released into the air were in less number (Cahaya and Nugroho, 2004). N level was needed by microorganism for conservation and forming the body cell. The more the content of nitrogen, the faster the organic materials were decomposed because decomposer microorganism needed N for its development. According to Higa (1990), N was absorbed by the plant roots in form of NO_3 (nitrate) and NH_4^+ (ammonium). Meanwhile, N fertilizer was absorbed in form of nitrate (NO_3) and nitrite ion ($N0_2^-$). Nitrogen needed prime nutrient for plant's growth that was really needed for forming and growing vegetative parts of the plant, such as leaves and stalks.

Phosphor: The content of phosphor before being conducted the experiment by sample treatment that was given EM of tomato showed that the result of similar mean was 1.04% and the result of phosphor in treatment of EM of intestine and EM of tomato was 0.7%. The content of P in third treatments was higher rather than SNI 19-7030-2004, which was 0.1%. Microorganism had an important role in absorbing phosphor. P was important for the fertility of the soil, which the nutritional intake was very important to help in improving nutrient level of the soil in reaching optimal intensity of the fertility. The content of P in compost materials would be used by most of microorganism for developing the cell. The microorganism in the materials could change nutrient to be PO_4^{2-} which was easily absorbed by the plant. The content of N influenced P in composting. The greater the N level, the more the microorganism that demolished phosphor. Thus, the content of phosphor in compost materials also increased (Hidayati, *et.al* 2008). Quite high content of Phosphor in the materials had a function for forming protein and stimulating the growth of the roots and forming the saplings.

Potassium: Potassium in sample treatment A and B had mean of 2.4%. Potassium in treatment C was 1.5% (<control potassium was 1.8%). The content of K in third treatments was higher rather than SNI 19-7030-2004, which was 0.2%. The process of decomposition by microorganism that was well would change the K level. This was in accordance with conducted research by Kurniawan (2012) that the more number the microorganism in degradation process, it could cause broken carbon chain to become more simple carbon chain. The broken carbon chain caused phosphor and potassium increased. The potassium level could increase by the use of EM4 bio activator because the microorganism and mineralization of potassium were more and more (Endang Sriningsih, 2013).

C/N Ratio: The highest content of C/N ratio was in control with mean of 18.32%, C/N Ratio in treatment A and C was 15.30% and in treatment B was 15.50%. The third treatment was in normal limits based on SNI 19-7030-2004 with an extension of 10-20. C/N ratio in P2 was lower rather than P1 and P3. This was because the microorganism that worked in decomposing compost materials in P2 was greater rather than P1 and P3. The content of C would be demolished by microorganism and was used as an energy sources in metabolism process and the multiplication of the cell, thus, it would result waste materials, such as organic acid and alcohol. Meanwhile, N was used for the process in forming either protein or protoplasm. If the compost material had too high content of C, the decomposing process would be too long. In contrary, if C was too low, the nitrogen residue would be too much. Hence, it would be formed ammoniac gas (NH_3) that caused the loss of N into the air. The more the N loss would make N component low, thus, C/N ratio of compost became high (Wahyuningtyas and Susanti, 2011). Compost with high content of C/N was not good for the plant and when it was applied directly to the plant, it would be occurred the competition between the plant and microbe in absorbing the nutrient. If the level of C/N ratio in compost was low, it would cause the banded nutrient in compost that had been released through mineralization process. Thus, it could be used by the plant (Hanafiah, 2005).

5.0 CONCLUSION

1. Organic fertilizer by adding EM of tomato needed maturation process in 6 weeks and parameters of temperature, pH, humidity, odor, color, texture, level of C, N, P, K, and C/N ratio qualified the requirement based on SNI 19-7030-2004.
2. Organic fertilizer by adding EM of intestine needed maturation process in 6 weeks and parameters of temperature, pH, humidity, odor, color, texture, level of C, N, P, K, and C/N ratio qualified the requirement based on SNI 19-7030-2004.
3. Organic fertilizer by adding EM of tomato needed maturation process in 5 weeks and parameters of temperature, pH, humidity, odor, color, texture, level of C, N, P, K, and C/N ratio qualified the requirement based on SNI 19-7030-2004.
4. The most effective way in making organic fertilizer was by using EM from synergic EM of tomato and intestine.

6.0 SUGGESTION

The farmers should use the waste from tomato as the mixture materials in making compost because it was more economic and did not depend optimally to the synthetic chemical fertilizers.

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