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The Role of Local Microorganisms Generated from Rotten Fruits and Vegetables in Producing Liquid Organic Fertilizer

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ABSTRACT

Experiment was conducted in order to find the role of local microorganisms (LoM) generated from rotten fruits and vegetables in producing liquid organic fertilizer (LOF). LoM resulting from rotten fruits and vegetables was dominated by Lactobacillus sp.. Therefore, in this experiment LoM was used to utilize cow urine to be LOF. The LoM was tested based on the composition of rotten fruit (F) and vegetable (V) and LoM consisted of LoM-1 (100% F); LoM-2 (75% F: 25% V); LoM-3 (50% F:50% V); LoM-4 (25% F-75% V); and LoM-5 (100% V). In this study other than LoM, EM4 was also used as a source of microorganism and positioned as a control. Cow urine and other materials were mixed and stirred homogenously. After that the LoM was put into the mixture and it then was incubated, respectively, for 6 days (I-6), 12 days (I-12), and 18 days (I-18). At the end of incubation, sample of LOF was taken up and analysis for pH, N, P, K and C. It showed that pH of LOF at all treatments decreased from initial pH of cow urine. The performance of N and K content was different throughout incubation, at I-6, I-12, and I-18. There was no significant differences of C content of LOF among treatments of different LoM at I-6 and I-18 with the exception of I-12. Meanwhile C/N ratio of LOF with different sources of LoM and EM4 at I-6, I-12 were no significant different ranged from 7-12 and 8-11, respectively. There was significantly different of C/N ratio among treatments of different LoM and EM4 at I-18. The C/N ratio of LOF with EM4 as starter showed different performance. The C/N ratio of it increased at I-6 and I-12, but gradually decreased at I-18. The LoM generated from rotten fruits and vegetables was dominated by *Lactobacillus sp*. and have potential to be a starter in producing LOF. The quality of LOF was determined by the incubation periods, mainly at I-18. Therefore, further investigation on this matter is highly recommended.

Keywords: cow urine, local microorganisms, EM4, liquid organic fertilizer, rotten fruit and vegetables

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1. Introduction

Sustainable agriculture is very important in supporting human life in the planet. This is due to the fact that sustainable agriculture has a potential to meet the needs of agriculture concerning conventional agriculture failed to do so. Types of farming using special farming technique in which the environmental resources can be fully utilized and at the same time ensure that no harm on it. Thus, this technique is environmentally friendly and ensure agricultural products are safe and healthy. Microbial populations that contribute to the fundamental processes may promote stability and productivity of agro-ecosystems.

Several investigations aimed at improving understanding of diversity, dynamism and importance of soil microbial communities and beneficial and cooperative role in agricultural productivity and sustainability. However, the contributions of plant growth promoting rhizobacteria (PGPR) and cyanobacteria in the development of safe and sustainable agriculture (Singh et al., 2011).

Sumardi et al. (1999) have evaluated the ability of *Bacillus chitinosporus* as bio-starter of organic fertilizer production at various media. It was found that the number of *B. chitinosporus* grown at the cow manure peaked at week 4 after incubation, while at the goat and chicken manure, respectively, was achieved at week 6 and 8 after incubation. In the last few decades about 35 strains of bacteria have been identified, and *B. chitinosporus* was one of the bacteria that have high ability in decomposing organic materials.

Organic materials other than a supporting function for the availability of soil nutrients, it is also possible for microorganisms may exist and grow. Therefore organic materials such as animal manure both dung and urine, rotten fruits and vegetables may be used as a medium for the growth of microorganisms (Widjajanto et al., 2016). They found that LoM generated from rotten fruits increased the quality of LOF based cow urine. This is may be due to the fact that the LoM affect the process of cow urine mineralization and other added organic materials. Liquid organic fertilizer may be fermented from cow urine by employing LoM and extra-effectiveness microorganism as EM4.

Bio-fertilizer becomes a critical component of organic farming (OF) that is prepared containing living cells or latent strain efficiently fix nitrogen, phosphate solvent or cellulolytic microorganisms. These are used for application to the seed, land or compost with the aim of increasing the amount of microorganisms and accelerate microbial processes that increase the availability of nutrients which can be easily assimilated by the plant. It is promoted to harvest the available system naturally, biological nutrient mobilization (Mahdi et al., 2010). Bio-fertilizer is an important component of integrated nutrient management. Bio-fertilizer plays a key role in the productivity and sustainability of land and also protects the environment as input and low cost for farmers (Mohammadi and Sohrabi, 2012).

Urine application directly into the field may loss N immediatelly, and therefore urine should be made as a LOF before it is being implemented into soil. Cow urine may be used as a LOF by employing the LoM generated from rotten fruits and vegetables as the LoM contained *Lactobaccillus plantarum, L. pentosus*, and *L. brevis*. The habit of microbial population in rhizosphere soil of OF is strongly influenced by agricultural practices such as cultivation, season, straw retention, burning, plant species, cultivars and genotypes, and the type of soil (Pereg and McMillan, 2015). Plant exudates may cause changes in soil characteristics such as pH and availability of carbon, affect the diversity and activity of microbial populations. The addition of microbes to agricultural land provides a valuable influence on soil microbial processes. Previous studies inspired the research team for further experiment on the bio-fertilizer, especially in its ability to provide nutrients for plants by dissolving phosphate and potassium and add nitrogen and organic matter into soil.

2. Materials and Methods

Experiment was conducted by employing the LoM that generated from rotten fruits and vegetables and commercial microoragnism as EM4. The LoM and EM4 were used to utilize cow urine in order to produce LOF. Experiments were conducted at the laboratory of Ecology and Crop Production, Department of Agriculture, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang-Indonesia, from May to November 2016.

The experiment was aimed to evaluate the role of LoM in producing LOF. The LoM was generated from rotten fruits and vegetables. It was generated based on the composition of rotten fruits (F) and rotten vegetables (V) as follows: 1. LoM-1 (100%F:0%V); 2. LoM-2 (75% F:25%V); 3. LoM-3 (50%F:50%V); 4. LoM-4 (25% F:75%V); and 5. LoM-5 (0%F:100%V). Commercial microoragnism as EM4 was also used as starter in producing LOF. The materials of Fresh fruits such as guava, sapodilla, bananas and vegetables such as beans, chick-peas, mustard were purchased at "Banyumanik, Semarang traditional market". Fresh fruits and vegetables then were left on the air temperature for about a week to rot.

Liquid Organic Fertilizer was made using cow urine that were colected from the farmers group of beef cattle named "Bangun Rejo", Krajan Polosiri Village, Bawen Sub-district, Semarang District, Central Java Province. Samples of cow urine were taken and analyzed for pH, N, P, K, and C. Cow urine then were mixed with other materials such as banana weviil, bambo root and molasses and the mixture then was stirred until homogeneous.

Liquid Organic Fertilizer then were produced by mixing homogeneous mixtures of LOF materials with LoM generated from rotten fruits and vegetables such as LoM-1, LoM-2, LoM-3, LoM-4, and LoM-5. Commercial microorganisms as EM4 were also used as a control. Before the incubation was performed, LOM (2% of total volume of LOF) was added into a homogeneous mixture of LOF materials. The mixture then was incubated anaerobically for 6 days (I-6), 12 days (I-12), and 18 days (I-18), respectively. Each experimental unit was replicated for 3 times.

After completion of the incubation, a certain amount of samples then were taken from each experimental unit and analyzed the content of N, P, K, C and pH. After laboratory analysis was completed, then it was followed by statistical analysis. Analysis of variance was used to analysis data that found throughout the experiment. Duncan multiple range test then was used to evaluate the differences among treatments.

3. Results and Discussion

Biofertilizers consist mainly of beneficial microorganisms that may release nutrients from raw materials and plant residues in the soil and make them available commercially where specific strains are used as bio-fertilizers (Mosa et al., 2014). Fruits and vegetables exist at ideal conditions for the survival and growth of many types of microorganisms. The microorganisms requiered energy source such as C, N, K and minor elements essential to make enzyme and their activity. Bacteria, actinomycetes and fungi of compost heap like any other living things need both carbon from carbohydrate and nitrogen from protein in the form of compost substrate subjected to thrive and reproduce. All microbes must have access to a supply of elements which cells were made (Raja et al., 2012).

In this experiment the efficacy of microorganisms generated from rotten fruits and vegetables were explored as starter in producing LOF. It was found that Lactic Acid Bacteria (LAB), other bacteria and fungi were exist and dominated the LoM. The population of LAB ranged between 4×10^{7} and 9×10^{8} CFU/ml, while the population of fungi were found between 2-4 x 10^{8} CFU/ml. The basic material used was cow urine. Its initial chemical properties of cow urine consists of 0.32%N, 20 ppm P, 0.27%K and 0.47%C, C/N ratio 1.5 : 1 with pH 8.6.

3.1. The acidity of LOF

Initial pH of cow urine was 8.6 where this pH in accordance with report of Haque and Haque (2006) that found the pH of cattle urine ranged between 8.6-9.4. The result of pH of LOF produced by employing different LoM (LoM-1, LoM-2, LoM-3, LoM-4, LoM-5 and EM4) at the I-6, I-12 and I-18 was presented at Fig.1. However, there were no significant differences among treatments on pH at all of incubation, at I-6, I-12 and I-18. These decreased from the initial pH of cow urine (8.6) to around 4.2 to 4.5. The decreased of pH was begun with the increased of pH due to volatilization and microbial decomposition of organic acids and the release of ammonia due to mineralization of organic matter. Other processes such as immobilization that produce ammonium and conversion of ammonium into nitrates also result in increased nitrate content and result in more acidic material conditions. The decreased of pH occurs at all of incubation times, at the I-6, I-12, and I-18. Pan et al. (2016) suggested that an alkaline pH (8.6) may enhance the composting process, controlling pathogenic fungi that prefer acidic growth conditions. The decomposition of organic matter at pH values of 6.0 or below may slow down the decomposition process, while pH values above 8.0 may cause the release of ammonia. This phenomenon shown as the initial pH of cow urine was 8.6 resulting the release of ammonia that influence the decreased`of pH at incubation time, at I-6, I-12 and I-18. The decreased of pH may due also the existence of lactic acid bacteria (LAB), other bacteria and fungi. Those three group of microorganisms were found during identification of LoM. The decreased of pH after incubation was due to the existance of Lactic Acetic Bacteria (LAB) that dominated the LoM. The presence of LAB may produce acetic acid that infuence the decreased of pH.

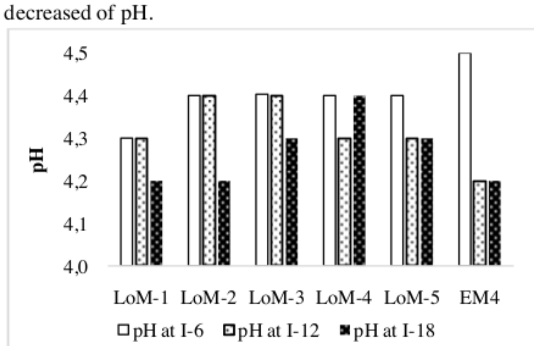

Fig.1. pH of LOF at different LoM and EM4 at I-6, I-12 and I-18

3.2. N, P and K constituents of LOF

The initial content of N, P and K of cow urine were 0.32%, 20 ppm and 0.27%, respectively. There were no significant differences of N content at I-6 and I-12 due to different LoM and EM4. However, N content increased significantly (P<0,05) at I-18 (Fig.2). The increased of N content at I-18 may be caused by the increased of N-organic mineralization. The highest of N content at the I-18 was reached at LoM-5. The decreased of N from the initial performance of cow urine to all of incubation may be due to anaerobic process occur during incubation. As anaerobic condition occur the presence of O_2 will be very limited and this condition may influence the activity of denitrification bacteria increased and consequently nitrogen will be released and resulted the content of nitrogen decreased. This explanation in accordance with the discovery of Tiedje et al. (1984) that found as O_2 content decreased up to 2% accelerate the rate of denitrification increased dramatically.

There were no significant differences of P and K contents of LOF at I-6, I-12 and I-18 due to different LoM and EM4 (Fig.3 and 4). At the I-6, I-12 and I-18 phosphorus levels were ranged between 37-67ppm, 43-60ppm and 33-137ppm, respectively. While the K content at I-6, I-12 and I-18, respectively, ranged between 0.53-0.58%, 0.31-0.52% and 0.12-0.41%. Phosphorus content of LOF with different LoM and EM4 throughout the incubation increased compared to that of P content of initial cow urine. The P content decreased as the periods of incubation increased with the exception of I-6. This phenomenon indicated that no consistency of P content at different incubation. In case of K content, it of LOF with different LoM and EM4 increased at I-6, and I-12, but it decreased at I-18.

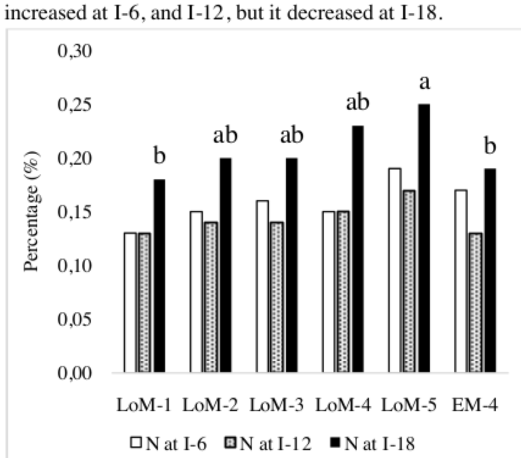

Fig.2. Content of N of LOF at different LoM and EM4 at the I-6, I-12 and I-18

3.3. C and C/N ratio of LOF

The initial C content of cow urine was 0.47%. There was no significant differences of C content of LOF among treatments of different LoM and EM-4 at I-6 and I-18 (Figure 5) with the exception of I-12, where it differed significantly (P<0,05) at I-12 (Fig.5). Initial C/N ratio of cow urine was 1.5. Compared to that of LOF the C/N ratio significantly increased. The C/N ratio of LOF with different sources of LoM at I-6, I-12 were no significant different ranged from 7-12 and 8-11, respectively. The C/N ratio of

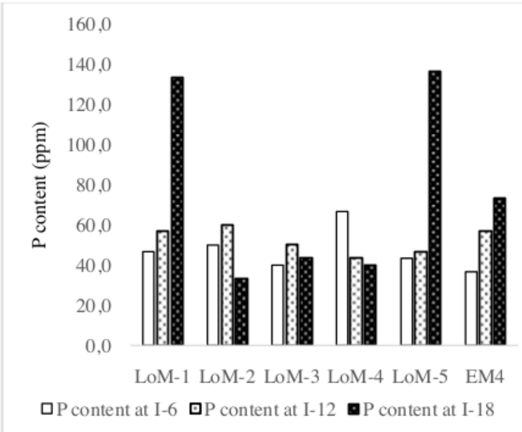

Fig.3. Content of P of LOF at different of LoM and EM4 at the I-6, I-12 and I-18

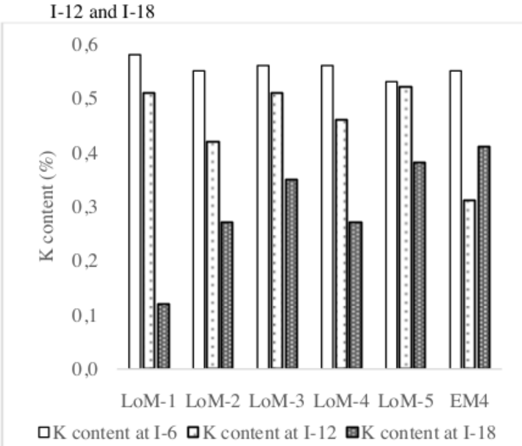

Fig.4. Content of K of LOF at different LoM and EM4 at the I-6, I-12 and I-18

LOF at I-6 with LoM-1 (11:1), LoM-2 (9:1), LoM-3 (10:1), LoM-4 (10:1), LoM-5 (7:1), and EM4 (9:1) (Fig.6). On the other hand, there was significantly (P<0,05) different of C/N ratio among treatments of different LoM and EM-4 at I-18. The C/N ratio of LOF was ranged between 5-8. The C/N ratio of LOF with EM4 as starter showed different performance. The C/N ratio of it increased at the first time (from I-6 to I-12) and gradually decreased at I-18. The decrease of C/N ratio may be due to the fact that transformation of organic carbon into carbon dioxide followed by a decrease in organic acid content. Accordingly, C/N ratio was changed dramatically from I-6 and I-12 to I-18. This phenomenon indicated that the process of incubation was completely finished at the I-18. The C/N ratio of LOF at I-6, I-12 and I-18 were ranged between 7-12, 8-11 and 5-8, respectively. In the bio-degradation of rotten fruit determined by using in-vessel non flow reactor type resulted that the process of composting was significantly affected by constituents of materials such as C/N ratio, moisture content, COD, pH, electrical conductivity, total solids and temperature. It process proceeds at a fairly quick rate (26 days) with forced aeration of 1 L/kg/Sc. From the analysis of C/N ratio, the reduction was great for mixtures 1:3 and 1:4, which implies that addition of excessive carbon content, is not encouraged. Moreover the final C/N ratio for the mix 1:5 (19.6) is indicative of the completion of composting in 26 days (Saravannan et al., 2003).

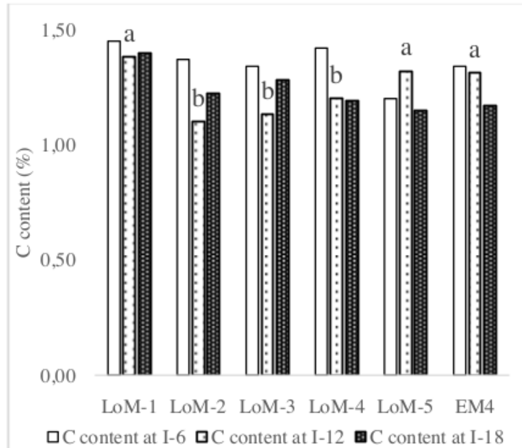

Fig.5. Content of C of LOF at different of LoM and EM4 at the I-6, I-12 and I-18

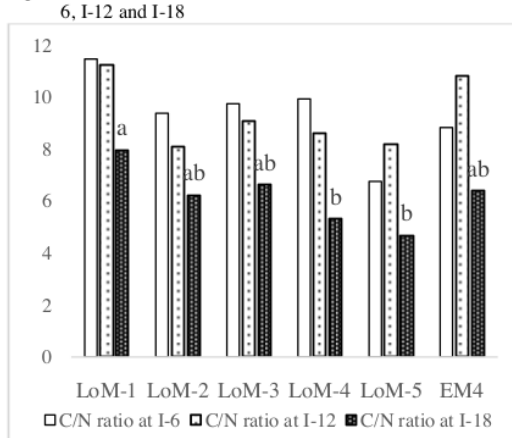

Fig.6. C/N ratio of LOF at different of LoM and EM4 at the I-6, I-12 and I-18

4. Conclusion

On the basis of the results found throughout the experiment it may be concluded that the LoM was dominated of *Lactobacillus plantarum*, *L. pentosus*, and *L. brevis*. All of those bacteria were play very important role in producing liquid organic fertilizers. Based on the N content of LOF and the incubation period, it can be concluded that the best-performing was reached by LoM-5 treatment at I-18, while on the basis of the C/N ratio, treatment LoM-1 at I-18 showed the best results. Therefore further research with 100% fruit and 100% vegetables as source of LoM at I-18 is highly recommended.

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