Organic Fertilizer Production From Cattle Waste Vermicomposting Assisted By Lumbricus Rubellus

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Abstract - Composting is decomposition of compound in organic waste by specific treatment using microorganism aerobically. Natural composting for producing organic fertilizer from manure and market waste utilize long time processing and less equal to the market demand. Vermicomposting is a technique to produce high quality compos fertilizer from biodegradable garbage and mixture of red worm (Lumbricus Rubellus). In conventional compos production took 8 weeks of processing time, in vermicomposting only took half processing time of conventional technique. It is occurred by red worm additional ease cellulose degradation contain in manure which is could not decomposed with composting bacteria. The purposes of this research are to investigate the effect of manure comparison to red worm growth and to evaluate the effect of comparison between manure and market waste to red worm growth. This research was conducted by vary the weight of red worm (100 gr, 200 gr, 300 gr, 400 gr, 500 gr) and market waste addition (50 gr, 100 gr, 150 gr, 200 gr, 300 gr). Moreover, 3 kg of manure was mixed by various weight of red worm, while variation of market waste addition was involved 500 gr red worm and 3 kg manure mixture. Optimum increasing weight of red worm that was obtained by 100 gr red worm addition is 160 gr within 2 weeks. In added market waste variation, the highest increasing of red worm was resulted by 50 gr market waste addition, with 60 gr increasing weight of red worm. Production of casting fertilizer was highly effected by composition of used materials such as medium, manure and red worm comparison as well as market waste additional.

Keywords: biotechnology, Lumbricus Rubellus, casting fertilizer, vermicomposting

I. INTRODUCTION

Indonesian national demand of fertilizer in year 2011 is about 5.1 million tons. Currently, those needs are supplied by inorganic fertilizer from 6 national fertilizer plants. In several years later, it is estimate that national production of fertilizer unable supply the national demand. Moreover, gas supply as raw material in fertilizer production decrease gradually. By the reason, it needs to investigate fertilizer process production which not involves natural gas, where an appropriate alternative is production of organic fertilizer (Budi, 2010). Organic fertilizer mostly or partly consist of organic material from plant and animal with modification process, can be in solid or liquid form that is used to supply organic substance for recovering physical, chemical and biological properties of soil. Organic fertilizer gives satisfied advantage to improve agricultural production, both quality and quantity, reduce environmental contamination and increase quality of sustainable land.

Compos as result of composting process is one of organic fertilizer that has important role in agricultural field because of its macro and micro nutrient compound. Another advantage of organic fertilizer are for recovery of soil structure, improving soil absorbency of water and nutrient, increasing bond force of sand soil, recovery of drainage and air separation in soil, involving decomposition process on soil. Moreover, plant with sufficient organic fertilizer is more resistance to plant disease (Warsana, 2009).

Compos processing conducted by maintaining nutrient compound, water content, pH, temperature as well as optimum aeration with watering and twisting. In preliminary composting step, temperature of compos is about 65-70 ^{0}C thus pathogen organism as bacteria, virus and parasite also weed in composed waste died. Moreover, in those condition there is no result of dangerous gases and unfavorable odor. Generally, composting completed in 6 to 8 weeks that was indicated by constant lowest temperature and stable materials. Its odor is soil smell, because of it similar content as soil, blackish brown color which was resulted by effect of stable organic compound. However, it final form is different with initial form because it was broken by natural decomposition of microorganism in compos (Afriansyah, 2010).

Organic fertilizer that was added into soil occurred several times of decomposition phase by soil microorganism to form humus or soil organic substance. Organic decomposition organism is not only micro fauna but also macro fauna as red worm. Vermicomposting involved red worm to decompose waste such as agricultural waste, kitchen rubbish, animal waste and industrial waste of agriculture based. These decomposition organisms ware grouped as organic decomposition bioactivator (Mashur, 2001). Generally, organic fertilizer was produced by natural composting process using micro fauna or macro fauna then form compos.

Natural composting process that usually use manure addition is conducted by microbe to degrade substance in manure becomes compos. Nevertheless, this natural composting utilizes long time processing, 8 weeks which is less efficient (Simanungkalit et. al., 2006). The long processing time is resulted by cellulose content in manure can not be degradable with compos microbe. Furthermore, undegradable cellulose inhibits planting root and also this technique economically less effective. A novel way to solve this problem for cellulose degradation is red worm (*Lumbricus Rubellus*) addition in composting processing. Organic fertilizer production with red worm activator use mixture of manure as raw material and red worm. In this case, red worm consume cellulose of manure that can not be degraded by compos bacteria. Result of red worm digestion is casting and it is used as additional food for compos bacteria. Thus, red worm

addition that is known as casting fertilizer or vermicomposting process can reduce production time of compos fertilizer. By red worm addition in compos production, it only takes half period of production time compare with conventional compos production technique (Nurmawati and Suhardianto, 2000).

Originally vermicomposting is Latin term where *Vermis* means red worm, while it is compos production process of biodegradable waste that forming high quality fertilizer by red worm (*Lumbricus Rubellus*). Red worm has main roles in soil and act as natural bioactivator to decompose weed. Red worm degradable waste and soil materials also return its digested materials to soil that resulted high nutrient compos. Most amount of bacteria inside red worm digestion system useful to change soil fertilization and accelerate plant growth. By the reason above, vermicomposting is one of promising technology as optimum organic medium (Singh et; al., 2008; Sathianarayanan, 2008).

Vermicomposting is biologically and chemically better than conventional compos and it has more microbe population content also nitrogen compound of vermicompos higher than conventional compos. It increases another nutrient content in soil such as phosphor, sulfur and magnesium. It contains amylase enzyme, lipase, cellulose and chitinase in function to break down organic substance in soil and secrete it as valuable nutrient for plant. Vermicompos consist of much humus that can increase soil fertilization. Humus is complex mixture contain dark colored matter that non dissolvable in water (i.e humic acid, fulfic acid and humin) and dissolve organic compound (acids and sugar). Soil fertilization was decided by humus value in soil, higher humic acid content the soil more fertile. This fertile condition can be obtained by using vermicompos as organic fertilizer, because of its high value of humic acid, approximately 13.88% (Kumari and Ushakumari, 2002). Vermicompos has crumble form which is can maintain stabilization and aeration phase of soil by avoid loss of soil because of surface flow. When soil insert to red worm digestion system, red worm secrete chemical compound called Ca-humat. It bonded soil particles become group of aggregate which is discharged in form casting. Specifically, those aggregate has ability to bond water and nutrient in soil (Blasi and Maso, 2008).

Furthermore, casting is red worm dung which can be utilized as fertilizer. It contains organic micro particles that was consumed by red worm and then was secreted. Casting compound depend on organic matter and type of red worm. Generally, casting contains nutrient that needed by plant such as nitrogen, phosphor, mineral and vitamin. Red worm convert half amount of organic matter becomes biomass and respiration product then secrete casting as high nutrient substance. Red worm and microorganism are symbiosis each other to accelerate organic compound decomposition. Casting can be used as fertilizer because of its complete nutrient content and high C/N that more than 20 (Simanungkalit et al, 2006). Casting fertilizer is fertilizer which is took from living medium of red worm. The living medium of red worm is various such as organic waste, sawdust, manure, straw and others. Red worm compos or casting involve macro organism that impact in suitably decomposition (Cavala, 2007).

The production of casting fertilizer should be suitable by red worm specific behavior. Some factors that impact red worm in life and growth period is temperature, which is maintained at adequate range of red worm growth temperature. Another factor is pH that sensitively impact red worm life cycle. The change of pH in red worm related to organic matter decomposition as chemical reaction sequence. Food supply also impact the red worm growth because of its nutrition compound. From the reason above, this research aims to investigate ideal food additional factor for red worm growth for producing optimum casting fertilizer.

II. MATERIALS AND METHOD

Materials

The red worm type *Lumbricus Rubellus* was used in this research together with manure and market waste. Red worm was provided by distributor while the manure was obtained from nearby animal husbandry. The market waste was collected three times a week from local market. The basin that used to place the mixture was wooden base made by 60 cm width; 15 cm height and conditional length depend on materials and location.

Production of casting fertilizer

Red worm was mixed and placed with the manure into basin. If the manure too dry because of air contact in long period (more than 1 week), it was suggested for closing the basin with plastic bag to maintain its humidity. After 2-3 weeks, the basin is treated for getting similar width, approximately 1 m. This treatment also for maintaining red worm spread out similarly. The next 2-3 weeks, the basin is treated as before. At this period, the manure is not in lumpy form anymore, most of them in crumbly form. In this step, on left and right side of basin is re-added by manure. It is because after consume any manure, red worm looked for another manure. This process is involved within 1 week. Manure on the basin 1 get more crumbly, drier, has no odor and no lumpy form. Manure that becomes casting then is filtered by sand filter for getting more fine form. The rest of sieving process is soil or unfiltered straw then is discharged. In this step, probably there is unfiltered casting which is needs to be discharged by placing lumpy manure around the mixture. After 1 week, red worm out from the mixture of casting and move to the new manure that added. Filtered casting can re-filter to get better result. Moreover, manure that contains casting is separated for further process of making casting. Then, casting packed by plastic bag.

III. RESULT AND DISCUSSION

Effect of Weight Comparison of Red Worm

Figure 1 below shows growth weight of red worm profile every 3 days that increase simultaneously. At the first 3 days, the phenomena that occurred in 100 gram addition of red worm and 3 kg manure is rapidly increasing weight of red worm about 75 % compare with initial weight. Nevertheless, the weight increasing of red worm at several days after is not as higher as weight increasing at the first 3 days, moreover it increased regularly.

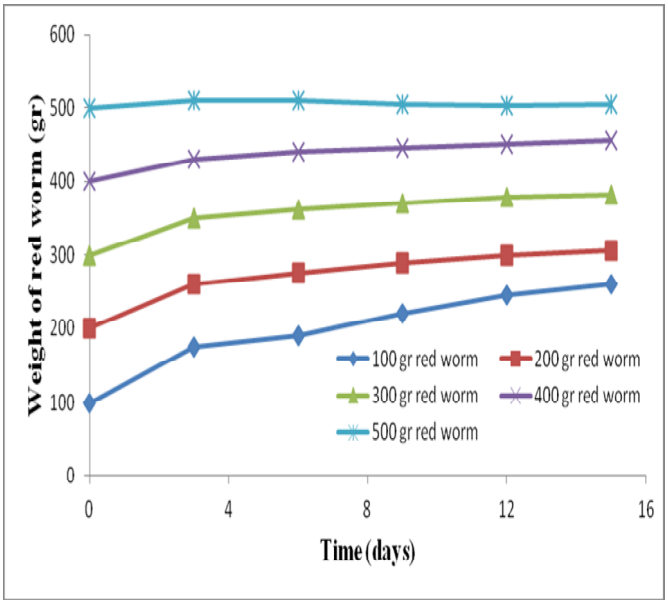

Figure 1. Effects of Red Worm Weight and Time

In composition of 100 gr red worm and 3 kg manure, red worm had sufficient nutrient for 30 days because red worm consumes the same amount nutrient of its weight. Furthermore, 200 gr, 300 gr, 400 gr red worm addition with 3 kg manure respectively, give lower weight increasing of red worm compare with 100 gr red worm addition. This is resulted by more amount of red worm effect more amount of manure consumed. As shown in Figure 1, 500 gr worm addition result weight gaining at the first 3 days and 6 days although it is not significantly. However, after 6th days the weight of red worm decrease, it is because 3 kg of manure is completely consumed after 6 days. It is showed by measurement of red worm weight at 9th days which its weight lower that the day before measurement.

The growth rate of red worm slower when more amount of red worm added in the medium. It is because red worm consume the same amount nutrient of its weight within 1 day, moreover nutrient addition must be equal with the amount of red worm (1:1). In this research, 3 kg nutrient used as medium and red worm addition vary from 100 gr to 500 gr. When 100 gr red worms investigated, 3 kg medium is sufficient as red worm nutrient for 30 days but it is completely consumed only 6 days for 500 gr red worms. By the reason, more amount of red worm dissemination, less nutrient consumed by red worm because it compete each other to get equal amount nutrient of its weight. However, growth rate of 500 gr red worms very low because of lack of nutrient (Garg et al, 2005).

Effect of Market waste Addition Comparison

Figure 3 describe growth weight of red worm (kg) and time (days) profile every 3 days with market waste addition 300 gr, 200 gr, 150 gr, 100 gr, and 50 gr, respectively. While 300 gr market waste additions conducted, in the 3rd days measurement there is declining of red worm weight. It is because red worms focus to consume the market waste first then the manure. On the other hand, market waste contains high water content and it is not fermented yet thus it is hardly consumed by the red worm. As shown in Figure 4.2, less market waste addition affect more weight gaining of red worm, because the load of red worm to consume market waste lower. Furthermore, red worm consume manure immediately which is easier consumption then market waste.

(a)

(b)

Figure 2 (a) Mixture of manure-red worm 0 day (b) Mixture of manure and red worm after 7 days.

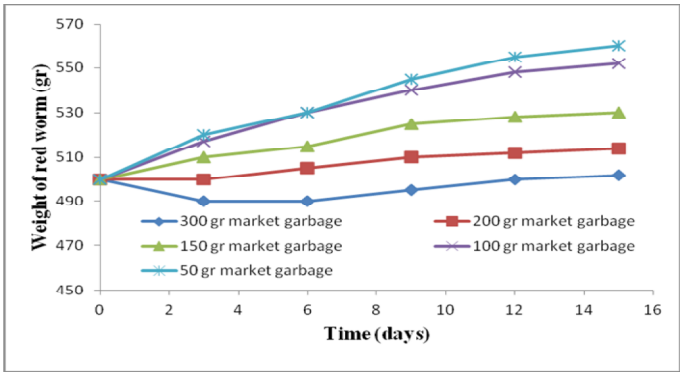

Figure 3 Weight of red worm profiles with the addition of market waste medium

Red worm that is placed on medium consume market waste with amount half of its weight every day. In addition, it needs 1 kg red worm for 0.5 kg market waste each day, 2:1. Every week, 1 kg red worm can process 3.5 kg market waste. If the growth condition unsuitable, the rate of consumption also decrease (Hebert, 2006). However, red worm needs oxygen for respiration and it can not alive under anaerobic condition. In this research, oxygen obtained from the ambient by using open medium basin for the red worm. If the amount of nutrient in medium too dense it causes less aeration and red worm become die. Aeration process was done by reverse medium regularly to increase amount of O_2 and to decrease

amount of CO_2 in the medium every 3 days (Munroe, 2003). However, sieving process is conducted for measuring weight of red worm. The medium temperature is controlled for optimizing of vermicomposting process. The temperature of medium holds on 25^0C in the morning and 27^0C in the afternoon, as stated by Razon et al (1981) with the range of 18^0C-27^0C.

(a)

(b)

Figure 4 (a) Mixture of manure and market waste before red worm addition (b) Mixture of manure and market waste with red worm addition after 7 days

Market waste can inhibit the growth of red worm, because of its high water content. High amount of water content on market waste and uncompleted fermentation process effected difficult consumption for red worm. Consequently, more market waste addition more time needs for red worm to consume the cellulose compound (Domjnguez et al, 1997).

IV. CONCLUSION

Composting using red worm *Lumbricus Rubellus* addition was involved by composition of medium that was used in process. Optimum condition in casting fertilizer production reached on 100 gr red worm addition and 50 gr market waste mixture by 3 kg manure. More red worms added, less red worm growth rate. Equally, more market waste added, less red worm growth rate.

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