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The Consequence of Vermicomposting Duration to Macronutrient Elements – C, N, P and K in Vermicompost

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Abstract

The effect of vermicomposting duration to macronutrient element in vermicompost was investigated. Three different treatments were prepared with eight replicates for each treatment namely cow dung: kitchen waste in 30:70 ratios (T_1), cow dung: coffee grounds in 30:70 ratio (T_2), and cow dung: kitchen waste: coffee grounds in 30:35:35 ratios (T_3). Vermicompost produced by *Lumbricus rubellus* were analyzed in week tenth and thirtieth. In conclusion, longer duration of vermicomposting will enhance the quality of vermicompost. This is shown by the percentage increase of macronutrient elements (N & P) and declining of C/N ratio.

Key words : duration, macronutrient, *Lumbricus rubellus*, vermicomposting.

Introduction

Under Ninth Malaysian Plan 2006-2010 (Economic Planning Unit, 2006), priority of waste management will continue to be accorded to the reduction, reuse, recovery and recycling of waste. As reported by Nadzri (2007), solid waste generated in 2005 was 19,100 tones per day in Peninsular Malaysia or an average of 0.8 kg per capita per day. The amount is expected to reach 30,000 tones per day in 2020. Recycling target have been set up 22 per cent by 2020 means 6600 tones solid waste will be recycle per day.

Solid waste in Malaysia generally consists of 45 % of food waste, 24 % plastic, 7 % paper, 6 % iron and 3 % glass and others made of the rest. Furthermore, reported by Rahimah (2007), 58.3% of all the wastes dumped to landfills composed of valuable organic waste.

With limited space and time, the best practical alternative needs to find out especially to manage organic waste in cost effective method particularly suitable with Malaysia condition as a multicultural country. Therefore, vermicomposting is highlighted as one of the recycling activities where as an eco-biotechnological process that transfer energy-rich and complex organic substances into humus like product known as vermicompost (Benitez et al., 2002). The presence of earthworms enhanced the decomposition of organic substances (Atiyeh et al., 2001) by non-thermophilic process (Elvira et al., 1996).

Vermicomposting is an aerobic and biooxidation process that depends upon earthworms to fragments, mix and promote microbial activity (Gaundi, 2002) in mesophilic temperature range, 35°C - 40°C (Sharma et al., 2005) with humid and slightly dark places, 40% - 50% moisture in beds, and pH of 7 (Kale, 1995). According to Ilyan (2007), feed materials with high in nitrogen help earthworms to grow faster and produce more cocoons in purpose to accelerate the earthworms' reproduction. About 5% to 10% of ingested material is absorbed into the earthworms' tissue for growth and metabolic activity and the rest is excreted as vermicast (Edwards & Lofty, 1972), also known as vermicompost.

Generally, the quality of vermicompost can be evaluated from macronutrient contents – C, N, P and K that depends on several factors such as type of substrate, aeration, humidity,

pH, temperature and the earthworms species used during vermicomposting (Pramanik et al., 2007) due to the mixture of vermicast with mucus secretion of the gut wall and microbes transformed it into value added material; vermicompost that high in nutrient elements contents (Nagavallemma et al., 2004). In addition, the degree of maturity that estimates from C/N ratio of vermicompost.

Materials and Methods

Experimental design

The experiments were conducted in plastic bin of size 45cm x 30cm x 30cm, with a hole at the bottom. Three different combinations of treatments were prepared with eight replicates for each treatment namely cow dung: kitchen waste in 30:70 ratio (T_1), cow dung: coffee grounds in 30:70 ratio (T_2), and cow dung: kitchen waste: coffee grounds in 30:35:35 ratio (T_3). The use of cow dung is only for supplement and also used as bedding material for the earthworms at early stage before they climatize with the treatments given.

In each the treatment plots, 60 healthy earthworms of approximately 11gm-15gm weight were introduced after 21 days of pre composting to avoid exposure of earthworms to high temperature during the initial thermophilic stage of composting. Mineral water was sprayed on the bin to maintain the moisture content of 50-60% while the entire bin covered with lids to avoid direct sunlight.

The sampling of vermicompost for macronutrient elements analysis including C, N, P, K, and C/N ratio were made on the tenth weeks (70 days) and thirtieth (210 days) weeks.

Micronutrient elements analysis

Organic carbon was determined by the partially-oxidation method (Walkley & Black, 1934). Nitrogen was estimated by Kjeldahl digestion. Phosphorus (as P) was detected by using colorimetric. For Potassium (as K), was measured by ignition method using atomic absorption spectrophotometry. Lastly, C/N ratio analyzed through the calculation.

Results and Discussion

Macronutrient elements-N, P and K

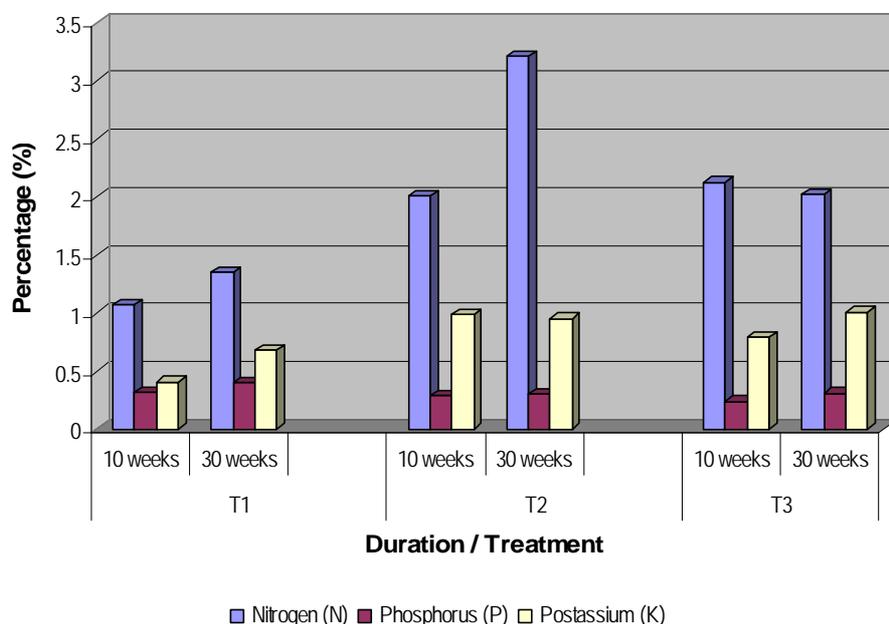


Figure 1: Differentiation of macronutrient elements – N, P and K between two different duration – 10 weeks and 30 weeks.

The N content of vermicompost from T_1 and T_2 on week thirtieth (1.35% & 3.21%) are higher than week tenth (1.07% & 2.01%) due to initial N content of organic wastes used as feed materials (kitchen waste & coffee grounds) to the earthworms and by the extent of its decomposition (Crawford, 1983; Gaur & Singh, 1995; Kaviraj & Sharma, 2003). These also might be enhanced by the decomposition of organic matter by lignolytic fungi (Viel et al., 1987) while the extent of N fixed by free living nitrogen-fixing bacteria (Kale et al., 1982). In contrast to T_3 where the percentage was decreased 0.11% on week thirtieth compared to week tenth that showed 2.13%. This small decrease (-5%) occurred due to need of little N and oxygen to maintain the stable condition of vermicompost (CIWMB, 2003).

Overall, the P and K content in vermicompost from all the treatments increased as the percentages were higher on week thirtieth (0.30% - 0.40% & 0.68% - 1.01%) compared to week tenth (0.24% - 0.32% & 0.41% - 0.99%).

According to Edwards and Lofty (1972), the increase of P during vermicomposting is probably due to mineralization of phosphorus as a result of bacterial and faecal phosphate activity of earthworms. This is supported by Satchell and Martein (1984) when they found that, the increase of P is direct action of earthworm gut enzymes and indirectly by stimulation of the microflora.

The increasing of K on week thirtieth indicating that the microbial flora influences the level of available potassium and acid production by the microorganisms seems to be prime mechanism for solubilizing the insoluble potassium (Edwards & Lofty, 1972). Referring to Kaviraj and Sharma (2003), the presence of large number of microflora in the gut of earthworm might play an important role in increasing P and K content in the process of

vermicomposting. In contrast, K in T_2 dropped due to the vermicomposting duration but only in small percentage (4%).

Other nutrient elements – C and C/N ratio

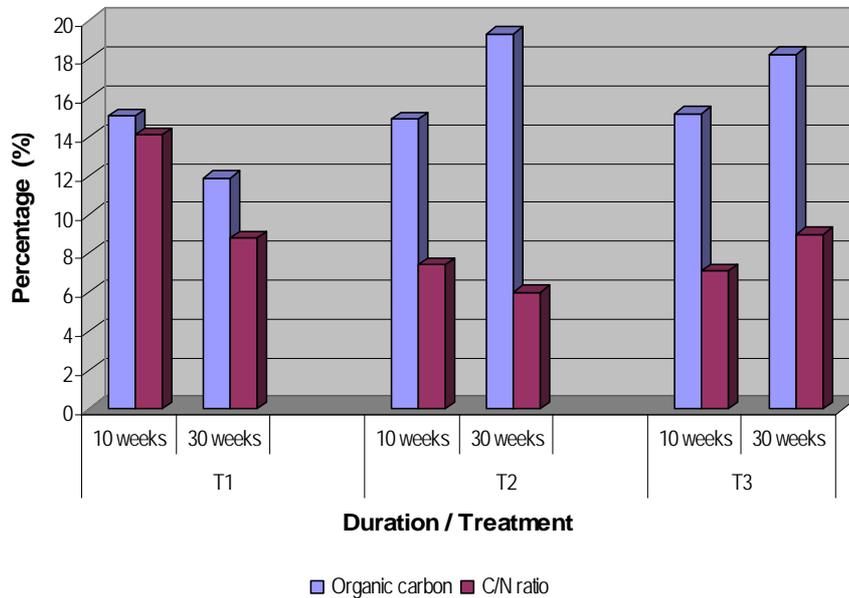


Figure 2: Differentiation of other nutrient elements – C and C/N ratio between two different duration – 10 weeks and 30 weeks.

The organic carbon (C) was higher in vermicompost from T_2 and T_3 on week thirtieth (19.32% & 18.27%) compared to week tenth (14.9% & 15.2%) due to stable condition of vermicompost as the oxidation of organic matter became slower when the vermicomposting almost completed.

In contrast to vermicompost from T_1 , where the C content decreased on week thirtieth (11.9%) compared to week tenth (15.1%) due to relative increase in N (26%) on loss of dry matter (C) as CO_2 as well as water loss by evaporation during mineralization (Viel et al., 1987). According to Pramanik et al. (2007), the increase in the earthworms' population also led to rapid decrease in C due to enhanced oxidation of the organic matter.

The completeness of vermicomposting that signify with the quality of vermicompost can be represented by C/N ratio where below 20 is indicative of acceptable maturity, while a ratio of 15 or lower being preferable as a better vermicompost (Morais & Queda, 2003). Generally, C/N ratio of vermicompost for all treatment (T_1 , T_2 and T_3) in range preferable (7.1 – 14.1) although the ratio increased from 7.1 in week tenth to 9.0 in week thirtieth for vermicompost from T_3 due to the increased of C and decreased of N.

Conclusion

The results demonstrated that longer duration of vermicomposting by using *Lumbricus rubellus* is able to increase the nutrient elements (N, P & K) while reducing the C/N ratio of vermicompost due to increase of N and decrease of C rapidly. The used of certain combination of organic material as feed material at specific ratio was found to be able to enhance the quality of end product, the vermicompost.

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