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ABSTRACT
Vermicomposting using *Lumbricus rubellus* for 49 days was conducted after 21 days of pre-composting. Three different combination 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). At the end of study, there was a significant difference between numbers of earthworms among the three different treatments ($p < 0.05$). In contrast with weights of earthworms there was no significant difference ($p > 0.05$) among the three treatments. By comparing the numbers and weights of earthworms in each treatments (T_1, T_2 & T_3) only T_2 indicated the difference was significant ($p < 0.05$). Therefore it can be concluded that coffee grounds influenced the development of earthworms' population. Nutrient elements in the vermicompost from each treatment were measured and relatively showed high percentage in C, N, P, and K. The presence of coffee grounds in vermicomposting in resulted significant reduction in C/N ratio and increase in mineral N. The data reveals that coffee grounds can be decomposed through vermicomposting by using *Lumbricus rubellus* into value-added material. With the correct ratio and suitable condition of kitchen waste, coffee grounds can also be used as stabilizer in vermicomposting.

Keywords: Coffee grounds, kitchen waste, *Lumbricus rubellus*, nutrient element, vermicomposting.

1. INTRODUCTION

From the statistics reported by the Economic Planning Unit (2006) in Ninth Malaysia Plan 2006-2010, the amount of solid waste generated in Peninsular Malaysia has increased from 16,200 tonnes per day in 2001 to 19,100 tonnes in 2005 or an average of 0.8 kg per capita per day. Solid waste in Malaysia on average consists of 45 % of food waste, 24 % plastic, 7 % paper, 6 % iron and 3 % glass and others made of the rest.

From these data, generation of solid waste is expected to reach 30,000 tones per day in 2020. Bolt from the blue, 58.3% of all the wastes dumped to landfills composed of valuable organic waste (Rahimah, 2007). Organic wastes become the major waste composition for Kuala Lumpur since 1970's (Sivapalan et al., 2002),

With the present approach, opening of new landfills and building up high technology incinerator, problems related to waste cannot be solved easily. Based on the characteristic of the MSW in Malaysia, incinerator is not a practical treatment to be used because the average moisture content of our waste is about 55% to 60% and with low calorific value (Sivapalan et al., 2002). With high moisture content, self sustained combustion requires auxiliary fuel when the energy that need to be used for incineration process also need to be used for drying process. Definitely this is not economic in maintenance and operation aspect when the price of fuel is increasing rapidly. Therefore Azni Idris et al. (2004) recommended that solutions should consider practical and economical way to optimize the utilization of any MSW before finally send for disposal. Under the Ninth Malaysia Plan (Nadzri, 2007), a target was set to recycle 22 per cent of MSW by 2020.

Vermicomposting has been identified as one of the potential activity in contributing toward the recycling target. Vermicomposting is cost effective and natural method alternative with shorter duration needed to accomplish; one to two weeks (Ilyan, 2007). It also can be classified as a simple biotechnology process of composting by using certain earthworms to enhance the process of waste conversion to produce better end product.

One of the earthworm species that is commonly used in vermicomposting is *Lumbricus rubellus*. Unfortunately, *L. rubellus* is not a local species. It originated from Australia. It is reddish brown or reddish violet, iridescent dorsally, and pale yellow ventrally. Compared to the local species, *L. rubellus* is more active in their eating behaviors and reproduction rate. The sexual maturity period for this species is 4 to 6 weeks under favorable conditions such as 25°C to 30°C for temperature, 40% to 45% of moisture contents and pH between 5.5 and 8.7. One pair of earthworms can produce 100 cocoons in 6 months (Ismail, 1997).

As a final product, vermicompost has higher percentage of nutrient elements than garden compost (Nagavallemma et al., 2004).

2. MATERIALS AND METHODS

2.1. Indoor Analysis

Plastic bins of size 45cm x 30cm x 30cm with four plots in each box and small holes at the bottom were used as worm bin. Three different combination 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 treatment plot, 60 weighted matured earthworms of approximately the same size were introduced after 21 days (3 weeks) of pre composting of organic wastes to avoid exposure of worms to high temperature during initial thermophilic stage. The duration of vermicomposting was 49 days (7 weeks). Moisture content of the treatment was maintained at about 50-60% by spraying the surface with mineral water.

After 49 days, the total number and biomass of the worms were determined as live weight after hand sorting and removal of all extraneous material. Two days before the determination, all the treatments were not watered to make the compost easy for sifting.

2.2. Statistical Analysis

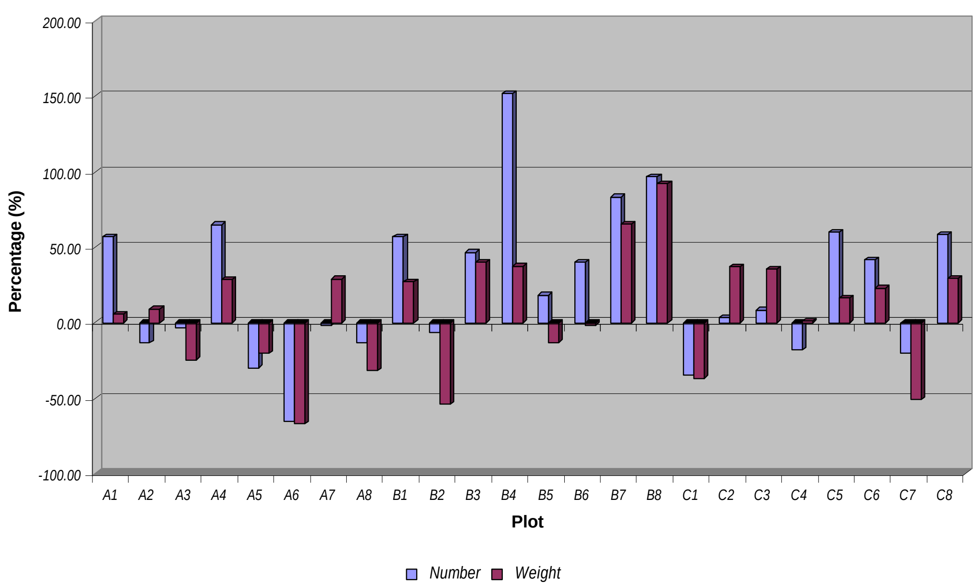
Statistical analysis was carried out using SPSS 11.0.1 (Standard Version) computer software package. One way analysis of variance (ANOVA) was done to analyze the significant difference between treatments during vermicomposting at 0.05% level of significance. Paired samples t-test was used to determine any significant difference between the numbers and weights of earthworms *(L. rubellus)* in each treatment.

2.3. Laboratory Analysis

The nutrient parameters of vermicompost produced after experiments were analyzed by using standard method. Organic carbon, C was determined by the partially-oxidation method (Walkley & Black, 1934). Nitrogen, N was estimated by Kjeldahl digestion. Phosphorus, P was detected by using colorimetric. For K, was measured by ignition method using atomic absorption spectrophotometry. C/N ratio analyzed through the calculation.

3. RESULTS AND DISCUSSION

3.1. Indoor and Statistical Analysis



Graph 3.1 Multiplication of earthworms using cow dung, kitchen waste and coffee grounds in different ratio.

3.1.1. T_1 – Cow dung : Kitchen waste (30 : 70)

The presence of kitchen waste which consists of animal such as fish residues enhance the moisture content that could result in putrification of waste (Kristiana et al., 2005). Thus, lead to anaerobicity condition which restricted the air movement through the available pore spaces in the substrates (Singh et al., 2004).

With scarcity of air, it regains more odourous anaerobic bacteria which thrive without air and make the earthworms became asphyxiate. Therefore, decrease number and weight of the earthworms (A6).

The odour that generated from metabolism of anaerobic microorganisms and anaerobic decomposition invited the mites and juvenile flies to become pests. Thus, interfere the earthworms' activities and lead towards the mortality of earthworms (A3, A5, A6, & A8). The survived earthworms fully utilized the feed materials available when there have increase in weight although numbers of earthworms were decreased (A2 & A7). For plot A1 and A4, without any presence of animal based residues while moisture contents were under control, enhanced the development of earthworms.

The paired samples test for numbers and weights of earthworms in T_1 indicates that the difference is not significant ($p > 0.05$, t=0.113, df=7). Thus, the kitchen waste as feed materials did not influence the development of earthworm population.

3.1.2. T_2 – Cow dung : Coffee grounds (30 : 70)

The fine grind of coffee grounds was recognized to help stabilized the condition in plot B1 to B8 by improving the texture, moisture retention capabilities which help to aerate the whole plots. Coffee grounds are high in N, P, K, Ca, Mg and S while pH of used grounds was 6.9 (Starbucks Coffee, 2005); a significant amount of buffer capacity that can lead towards neutral pH. The aroma of roasted coffee (coffee grounds) contains more than 800 volatile molecular species (Illy, 2002) is predicted to has the capability to discourage pests which interfering the earthworms. The presences of fungi during vermicomposting became additional supplement to the earthworms and contribute to the increase number and weight of the earthworms (Edwards & Fletcher, 1998) as in B1, B3, B4, B7 and B8. The unstable temperature influences by moisture contents, gave impacts to plot B2, B5, and B6.

In contrast to the paired samples test for T_2, the difference in numbers and weights is significant ($p < 0.05$, t=3.749, df=7). Therefore, the coffee ground influenced the development of earthworm population.

3.1.3. T_3 – Cow dung : Kitchen waste : Coffee grounds (30 : 35 : 35)

The ability of coffee grounds to generate heat (Starbucks Coffee, 2005) and preserve the moisture content of the feed materials help to reduce the moisture content in the kitchen waste. Simultaneously, amend it to be suitable places for the earthworms' reproduction by stabilize the pH, increase the aeration circulation and turn down the temperature to the suitable range for reproduction process (25°C to 30°C). Thus enhance the earthworms' reproduction in plot C2, C3, C5, C6, and C8.

The high moisture content caused by the presence of animal based residues decreases number and weight of earthworms (C1 & C7). Consequently, invite the mites and juvenile flies to become pests. The ability of survived earthworms in C4 to fully utilized available feed materials, increase the weight of earthworms.

With the used of kitchen waste in T_3 though the ratio is smaller than T_1, there is no significant difference in the numbers and weights of earthworms ($p > 0.05$, t=0.994, df=7). It clearly indicated that the mixture of kitchen waste and coffee grounds at the same ratio did not influence the development of earthworms.

3.2. Laboratory Analysis

Table 3.1
Nutrient elements in vermicompost from three different treatments.

	Vermicompost		
Nutrient elements	***T_1***	***T_2***	***T_3***
Organic carbon	15.1 %	14.9 %	15.2 %
Nitrogen (as N)	1.07 %	2.01 %	2.13 %
Phosphorus (as P)	0.32 %	0.29 %	0.24 %
Potassium (as K)	0.41 %	0.99 %	0.79 %
C/N ratio	14.1 %	7.4 %	7.1 %

The increase in the earthworms' population lead to rapid decrease in C as CO_2 as well as water loss by evaporation during mineralization due to enhanced oxidation of the organic matter (Pramanik et al., 2007). The N content in vermicompost also relics on to the extent of N fixed by free living nitrogen-fixing bacteria (Kale et al., 1982).

Referring to Kaviraj and Satyawati (2003), acid production during organic matter decomposition by the microorganisms is the major mechanism for solubilisation on insoluble P and K. Therefore, 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. The increase of P is direct action of earthworm gut enzymes and indirectly by stimulation of the microflora (Satchell & Martein, 1984).

The C/N ratio used as a parameter to determine the degree of maturity of compost. Thus represent its agronomic quality. C/N ratio below 20 is indicative of acceptable maturity, while a ratio of 15 or lower being preferable (Morais & Queda, 2003). Vermicompost from all treatments are considered preferable (Table 3.1). The difference for C is not very significant among three treatments rather than N. The percentage of N for T_2 and T_3 are doubled than T_1 which definitely influence the C/N ratio.

4. CONCLUSION

The coffee grounds can be decomposed through vermicomposting by using *Lumbricus rubellus* into value-added material. With the correct ratio and suitable condition of kitchen waste, coffee grounds can also be used as stabilizer in vermicomposting that indirectly provide a better environment for the earthworms (*L. rubellus)* to develop their population (grow) and produce a high quality of vermicompost. Consequently, vermicompost can play a role as a conditioner that act as organic soil stabilizer which is more environmental friendly to the soil in agriculture.

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