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Suan Sunandha Science and Technology Journal

Amount of macronutrients in vermicompost from tissue paper waste with earthworm

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Abstract

This research aimed to study and compare the macronutrients in vermicompost from tissue paper waste with earthworm. Two species of earthworm (*Eudrilus eugeniae* and *Pheretima peguana*) were used in this study. The experiments were set up as 4 sets and were operated in plastic tub (60 x 40 x 13 cm) for 4 weeks. During the degradation, the moisture content was controlled at 70-80% by using sprinkling water. The macronutrients including nitrogen, phosphorus and potassium were analyzed. The result showed that the macronutrients (nitrogen, phosphorus and potassium content) in vermicompost from *Eudrilus eugeniae* were 0.0161, 16.420 and 82.428 mg/kg, respectively. The macronutrients (nitrogen, phosphorus and potassium content) in vermicompost from *Pheretima peguana* were 0.0142, 14.631 and 54.123 mg/kg, respectively. In addition, the macronutrients in vermicompost from two species of earthworm were significantly different between *Eudrilus eugeniae* and *Pheretima peguana* ($P < 0.05$).

Keywords: Tissue papers, Earthworms, *Eudrilus eugeniae*, *Pheretima peguana*, Macronutrients

1. Introduction

In the past 10 years (2008-2016), the amount of solid waste has increased every year. We had the amount of 27.06 million tons of solid wastes produced and increasing amount of 1.13 to 1.14 kg per person till 2016. (Pollution Control Department, 2017)

Tissue paper plays the more important role in our daily lives because it can be used for many purposes, including bathroom and on the dining table. The consumption of paper is associated with the growth rate of the population. Plants such as reeds, jute, sugarcane, cotton, cane are also used to make pulp. The chemical composition of the wood consists of three things: 1) cellulose, 2) hemicellulose, 3) lignin (Nuonphudsa, 2014).

Waste disposal technology can be divided into 3 major systems:

1. Composting system. It is the degradation of organic substances by the biological process of microorganisms as the decomposition agent to transform into relatively stable minerals. The composting process can be divided into two processes: the aerobic decomposition process and anaerobic decomposition process.

2. The incinerator system. It is the destruction of solid waste by incineration in a properly designed and constructed incinerator with an incineration temperature of 850-1,200 degrees Celsius for almost destruction.

3. Landfill system. Sanitary Landfill is the disposal of solid waste by bringing it to a landfill in the area provided, which is an area that has been selected according to the rational principles. Each waste disposal technology has different advantages and disadvantages. (Pollution Control Department, 2004)

Earthworms are animals that are common in the soil. They live in compost piles, under piles of manure, and in areas with sufficient sources of food and moisture. Earthworms are divided into two groups: red earthworms and gray earthworms. They

Suan Sunandha Science and Technology Journal

are very suitable for decomposing waste and food waste. Gray earthworms live in the soil and digest little food. Earthworms allow the process of degradable and it can increase its nutritional value higher than usual. Earthworms that are effective in digesting plant or organic debris have 5 species consisting of *Eisenia foetida*, *Eudrilus eugeniae*, *Lumbricus rebellus*, *Pheretima peguana* and *Pheretima posthuma*. There are two varieties of earthworms that are commonly used to decompose organic matter for fertilizer production in Thailand: The Phoerentima species. *Eudrilus eugeniae* and *Pheretima peguana* (Tancho, 2000).

Organic Solid Waste Disposal in nature can be degraded with the process by microorganisms and soil animals such as earthworms. Earthworm manure can be used to improve soil quality. Compost can be produced with feeding earthworms inside containers such as plastic drawers and plastic tubs. This process can reduce odors and decompose waste or manure quickly into compost.

2. Materials and Methods

2.1 Materials

(1) Two species of earthworms are *Eudrilus eugeniae* (Figure 1) and *Pheretima peguana* (Figure 2).

Figure 1. *Eudrilus eugeniae*.

Figure 2. *Pheretima pequana*.

(2) Cow dung was used as a standard background medium that served as a control.

Preparing the area for raising earthworms: Cow dung was passed through a 2 mm sieve and dried in the sun for 14 days to remove earthworms and cocoons of earthworms and other organisms. Then, soaked 1-2 nights in water, (total of 3 rounds of water irrigations). This process took around 7 days to cool the cow dung and make it suitable for earthworm living. The pH of cow dung was measured and controlled in the range of 5.0 - 8.0 by lime solution (spray). The 10 kg of cow dung was put into a plastic tub and the moisture level controlled at 70-80% by sprinkling distilled water onto the compost medium when necessary (Department of Agricultural Extension, 2006).

(3) The diameter of the plastic tub was 60 x 40 x 13 cm, and the drainage holes were 20-30.

(4) Tissue papers from Amazon Coffee Shop were prepped.

Preparation of food for feeding earthworms: The tissue papers from an Amazon Coffee Shop were collected and cut into a size of 0.5 - 1 cm and then fermented for 7 days before degradation. This is because earthworms feed on spoiled organic waste that decomposes into a liquid (Kongthong, 2018).

2.2 Experimental setup

There were 2 species of earthworms used in this research: *Eudrilus eugeniae* and *Pheretima peguana*, aged 30-45 days, in four replicates for 30 days.

Set 1 200 g *Eudrilus eugeniae* and 10 kg cow dung. (Figure 3)

(1) (2)

Figure 3. (1) *Eudrilus eugeniae* (2) cow dung.

Suan Sunandha Science and Technology Journal

Set 2 200 g *Eudrilus eugenniae*, 10 kg cow dung and 800 g tissue paper (Figure 4)

(3) (4) (5)

Figure 4. (3) Eudrilus eugeniae (4) cow dung (5) tissue paper.

Set 3 200 g *Pheretima peguana* and 10 kg cow dung (Figure 5)

(6) (7)

Figure 5. (6) *Pheretima pequana* (7) cow dung.

Set 4 200 g *Pheretima peguana*, 10 kg cow dung and 800 g tissue paper (Figure 6)

(8) (9) (10)

Figure 6. (8) *Pheretima pequana* (9) cow dung (10) tissue paper.

During the study, no extra feed was added at any stage. The sets were covered to protect from sun light. Additionally, the degradation of tissue was observed till the final product had black, brown and light brown colors. Then, the cow dung and vermicompost was separated and everything was dried and sieved.

The macronutrients were analyzed in vermicompost from tissue paper waste with two species of earthworms *Eudrilus eugeniae* and *Pheretima peguana* by analyzing the nitrogen, phosphorus and potassium.

2.3 Laboratory Analysis Methods

The samples were air-dried before control analysis of nitrogen, phosphorus and potassium. All the samples were analyzed in triplicate and the average results were used for comparisons.

Nitrogen content was analyzed by the Kjeldahl method and started from weighing 1 gram of vermicompost and putting the sample in a Kjeldahl tube. A volume of 100 ml deionized water was added. Then, 15 g of heavy potassium sulfate, 0.7 g of mercuric oxide, and 25 ml of concentrated sulfuric acid were added. Digestion at 380℃ was done using a digestion machine for about 30 minutes, until it became a clear liquid and was set aside to cool. 100 ml deionized water was added Distillation was carried out with a steam distiller and ammonia was supported by boric acid mixed with an indicator composed of a mixture of methyl red and methylene blue. Distillation was done until the volume was at least 150 ml and cooled at room temperature. Titration was carried with standard solution 0.05 normal sulfuric acid and when it reached the end point, it got a light purple color (Choo-in, 2014).

Phosphorus content was analyzed by the Bray II method and the machine used was the spectrophotometer. Approximately 1 gram of sample was weighed in a 250 ml Erlenmeyer flask, 10 ml of Bray II extract was added, shaken for 1 minute and filtered with No.5 filter paper. 10 ml of the filtered solution was pipetted into a test tube, into which 1 ml of reagent solution was added, mixed well, and set aside for 30 minutes. The absorbance was measured at the wavelength of 880 nm and the obtained absorbance was compared with the standard curve to determine the phosphorus concentration (Choo-in, 2014).

Potassium content was analyzed by the Atomic Adsorption Spectrophotometer. Approximately 2 g of sample was weighed in a 250 ml Erlenmeyer flask, then 20 ml of mixing solution was added for extraction, shaken for 30 minutes, and strained with a filter. Afterwards, the volume

was adjusted to 25 ml with deionized water in a volumetric flask. Standard solutions were prepared at concentrations such as 0.5, 1.0, 2.0 mg per liter. Content was analyzed using flame atomic absorption spectrophotometer (Choo-in, 2014).

2.4 Data treatment

Samples of vermicompost that were sifted between cow dung and fertilizers were collected using a basket of vermicompost to be analyzed. Nitrogen, phosphorus and potassium content in three repetitions were done in a chemical laboratory after pre-composting for 1 week. The storage period was 4 weeks.

The data were analyzed to find the means to compare the difference in the macronutrients in vermicompost from tissue paper waste with two species of earthworms *Eudrilus eugeniae* and *Pheretima peguana*.

2.5 Statistical analysis

The differences in macronutrients were statistically interpreted using t-test at 95% confidence. These tests were performed to find out any significant comparison between the macronutrients in vermicompost from tissue paper waste with two earthworm species. Statistical significant was at $P < 0.05$.

3. Results and Discussion

3.1 The macronutrient in vermicompost

The macronutrient which was nitrogen content in vermicompost from the degradation of two species of earthworms is shown in Table 1.

Table 1. Nitrogen content (mg/kg) of the vermicompost from 4 sets of experiments.

Week	*Eudrilus eugeniae*		*Pheretima peguana*	
	Cow dung	Cow dung mixed with tissue paper	Cow dung	Cow dung mixed with tissue paper
1	0.0167	0.0133	0.0130	0.0143
2	0.0163	0.0130	0.0120	0.0160
3	0.0160	0.0173	0.0130	0.0133
4	0.0157	0.0207	0.0160	0.0133
$\bar{X}$	0.0162	0.0161	0.0135	0.0142

For the degradation of *Eudrilus eugeniae*, nitrogen content in vermicompost from cow dung degradation was in the range of 0.0157-0.0167 mg/kg ($\bar{X}$ = 0.0162) and showed the maximum value at 0.0167 mg/kg at 1 week while the degradation of cow dung mixed with tissue paper was in the range of 0.0130-0.0207 mg/kg ($\bar{X}$ = 0.0161) and the maximum value was 0.0207 mg/kg at 4 weeks. For the degradation of *Pheretima peguana*, nitrogen content in vermicompost from cow dung degradation was in the range of 0.0120-0.0160 mg/kg ($\bar{X}$ = 0.0135) and showed the maximum value at 0.0160 mg/kg at week 4 whereas cow dung mixed with tissue paper degradation was in the range of 0.0133-0.0160 mg/kg ($\bar{X}$ = 0.0142) and the maximum value was 0.0160 mg/kg at 2 weeks. Phosphorus content in vermicompost from the degradation of two species of earthworms is shown in Table 2.

Table 2. Phosphorus content (mg/kg) of the vermicompost from 4 sets of experiments.

Week	*Eudrilus eugeniae*		*Pheretima peguana*	
	Cow dung	Cow dung mixed with tissue paper	Cow dung	Cow dung mixed with tissue paper
1	13.606	17.188	13.326	13.924
2	13.361	17.378	13.924	14.324
3	17.644	16.478	13.490	14.825
4	20.687	19.306	14.920	15.451
$\bar{X}$	16.325	17.588	13.915	14.631

Table 2 shows the phosphorus content in vermicompost by degradation with *Eudrilus eugeniae*. Cow dung degradation was in the range of 13.361-20.687 mg/kg ($\bar{X}$ = 16.325) and showed the maximum value at 20.687 mg/kg at 4 weeks while the degradation of cow dung mixed with tissue paper was in the range of 16.478-19.306 mg/kg ($\bar{X}$ = 17.588) and the maximum value was 19.306 mg/kg

Suan Sunandha Science and Technology Journal

at 4 weeks. For the degradation of *Pheretima peguana*, phosphorus content in vermicompost from cow dung degradation was in the range of 13.326-14.920 mg/kg ($\bar{X}$ = 13.915) and showed the maximum value at 14.920 mg/kg at 4 weeks whereas cow dung mixed with tissue paper degradation was in the range of 13.924-15.451 mg/kg ($\bar{X}$ = 14.631) and the maximum value was at 15.451 mg/kg at 4 weeks.

Potassium content in vermicompost from the degradation of two species of earthworms is shown in Table 3.

Table 3. Potassium content (mg/kg) of the vermicompost from 4 sets of experiments.

Week	*Eudrilus eugeniae*		*Pheretima peguana*	
	Cow dung	Cow dung mixed with tissue paper	Cow dung	Cow dung mixed with tissue paper
1	86.870	94.798	46.317	76.699
2	67.552	79.297	37.882	42.592
3	65.782	78.824	37.775	41.476
4	68.365	76.794	46.928	55.725
$\bar{X}$	72.142	82.428	42.226	54.123

Table 3 shows the potassium content in vermicompost by degradation with *Eudrilus eugeniae*. Cow dung degradation was in the range of 65.782-86.870 mg/kg ($\bar{X}$ = 72.142) and the maximum value was 86.870 mg/kg at week 1 while the degradation of cow dung mixed with tissue paper was in the range of 76.794-94.798 mg/kg ($\bar{X}$ = 72.142) and the maximum value was 94.798 mg/kg at week 1. For the degradation of *Pheretima peguana*, potassium content in vermicompost from cow dung degradation was in the range of 37.775-46.928 mg/kg ($\bar{X}$ = 42.226) and the maximum value was 46.928 mg/kg at weeks 4 weeks whereas cow dung mixed with tissue paper degradation was in the range of 41.476-76.699 mg/kg ($\bar{X}$ = 42.226) and the maximum value was 76.699 mg/kg at week 1.

3.2 The comparison of the macronutrient in vermicompost from tissue paper waste degradation with two species of earthworm.

Analysis of the macronutrients in vermicompost obtained from cow dung degradation and cow dung mixed with tissue paper degradation, was carried using by analyzing the nitrogen content, potassium content, and phosphorus content. The means were obtained to compare the differences in macronutrients in vermicompost obtained from the decomposition of the tissues paper waste by the 2 species of earthworms. Nitrogen content, potassium content and phosphorus content maximums as noticed in vermicompost by *Eudrilus eugeniae* were at 0.0161, 82.428 and 16.420 mg/kg respectively and by *Pheretima pequana* were 0.0142, 54.123 and 14.631 mg/kg respectively. Statistical significance was at $P < 0.05$ (Figure 7).

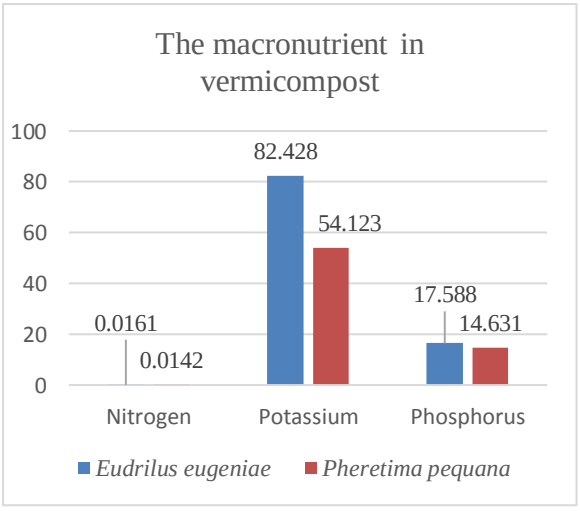

Figure 7. Comparison of the differences in the macronutrient in vermicompost from tissue paper waste with earthworm 2 species.

4. Conclusions

This study concludes that there are macronutrients in vermicompost from tissue paper waste degraded with two earthworm species for 4 weeks. Maximum nitrogen and potassium contents in vermicompost by cow dung degradation with *Eudrilus eugeniae* at week 1 were 0.0167 and 86.870 mg/kg, respectively. Maximum phosphorus content at week 4was 20.687 mg/kg. Nitrogen content and phosphorus content in vermicompost by cow dung mixed with tissue paper degraded with *Eudrilus eugeniae* maximum at week 4 were

0.0207 and 19.306 mg/kg, respectively. Maximum potassium content at week 1 was 94.798 mg/kg. Nitrogen content, phosphorus content and potassium content by cow dung degradation with *Pheretima pequana* had maximum values at week 4, which were 0.0160, 14.920 and 46.928 mg/kg respectively. Nitrogen content by cow dung mixed with tissue paper degraded with *Pheretima pequana* had a maximum at week 2of 0.0160 mg/kg. Maximum phosphorus content at week 4 was 15.451 mg/kg. Potassium maximum content at week 1was 76.699 mg/kg.

The mean was obtained to compare the differences in macronutrients in vermicompost obtained from the decomposition of the tissue paper waste by the two species of earthworms. Nitrogen content, potassium content and phosphorus content with maximums as noticed in vermicompost by *Eudrilus eugeniae* were 0.0161, 82.428 and 16.420 mg/kg respectively and *Pheretima pequana* were 0.0142, 54.123 and 14.631 mg/kg respectively. Statistical significance was at $P < 0.05$.

5. Recommendations

Integrated waste management systems should be developed and promoted. This is to enable the local community to eliminate waste completely and sustainably. Promoting knowledge of *Eudrilus eugeniae* earthworms can help generate additional income. Also, it can be used to manage household waste and earthworm manure in local communities.

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