NPK Contents of Vermicast as Influenced by Varying Substrates

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Abstract

Vermicomposting has been practiced for many years by several researchers for its positive outcomes toward sustainable agriculture. This study was conducted to assess the N, P, K content of vermicast as influenced by different substrates. Approximately, four (4) samples in each substrate as initial sample and vermicast as final sample were collected in the study. Varying substrates include the use of cow manure, mudpress, banana peelings, some leguminous plants namely kudzu and kakawate. Substrates and vermicasts among all treatments range from slightly acidic to slightly alkaline condition. There were considerably decreased in terms of pH, total N, K from its initial sample (substrate) to its final sample (vermicast) except for total P. Thus, this could be attributed to the nature and properties of varying substrates fed to the earthworms.

Keywords: Vermicast, organic substrates, total N, P, K

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INTRODUCTION

In today's generation, organic fertilizer had gained more attention due to heavy doses of chemical fertilizers and pesticides are being used by the farmers to get a better yield of various crops. These chemical fertilizers and pesticides decreased soil fertility and caused health problems to the consumers. Due to adverse effects of chemical fertilizers, interest has been stimulated for the use of organic manures. The Philippine Organic Agriculture Act (RA 10068) was approved to promote and implement the practice of organic agriculture in the Philippines that will cumulatively condition and enrich the fertility of the soil, increase farm productivity, reduce pollution and destruction of the environment. Organic fertilizers are effective in improving soil fertility and agricultural production by providing essential elements (N, P, K). Nevertheless, effectiveness of organic fertilizer requires time but its effects are sustainable in the long run. The release of nutrients from organic fertilizer is gradual and as microorganisms in the soil breakdown and decomposes the organic matter and makes the nutrients available for plants (Mencide, 2011). Organic agriculture includes the practices of vermiculture and vermicomposting.

Basically, vermiculture is the science of breeding and raising earthworms. According to Entre Pinoys (2010), it defines the growing potential for waste reduction, fertilizer production, as well as an assortment of possible outcomes for the future use.

Vermicomposting is the process of producing organic fertilizer or the vermicompost derived from different substrates or biodegradable materials that are processed by earthworms. Composting with earthworms lessens the disposal of agricultural wastes and increases the benefits of high quality compost (Rogayan, 2010). Furthermore, vermicomposting is a simple biotechnological process of composting in which certain species of earthworms are used to enhance the process of waste conversion and produce a better product. The resulting product of vermicomposting is commonly known as 'vermicast'. Vermicast is an organic fertilizer which is of high quality and it is very useful in enriching the soil as soil conditioner. Moreover, vermicast which is high in microbial enzymes and plant growth regulators and is also fortified with pest repellence attributes (Vermi Co. 2001 as cited by Ranin, 2015). According to Vasanthi and Kumaraswamy (1999) vermicast contains essential nutrients essential for plant growth, thus minimizing the application of chemical fertilizers.

This study was conducted to assess the nutrient content (NPK) of vermicast produce by *E. eugeniae* when fed with different mixtures of substrates. This research also aims to identify the changes of nutrient content of the different substrates after the vermicast production.

MATERIALS and METHODS

Treatments and Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. T_1= 1:1:1 cow manure, mud press, and banana peelings; T_2= 1:1:1:1 cow manure, mud press, banana peelings, and rice straw; T_3= 1:1:1:1 cow manure, mud press, banana peelings, and kudzu; T_4= 1:1:1:1 cow manure, mud press, banana peelings, and kakawate.

Preparation of Organic Materials and Vermicomposting Process

The use of plastic containers was provided with wire holes at the bottom for drainage. The substrates such as kudzu, kakawate, rice straw, banana peelings, mudpress and cow manure were collected in the field. These materials were shredded and mixed into the dried and compounded cow manure.

Vermi worms used in the study were cultured and collected at Eco-FARMI, VSU, Baybay City, Leyte. These vermi worms are identified as 'African night crawler' or scientifically known as *Eudrilus eugeniae.* A total of 500 g of earthworms was introduced into each treatment. The containers were placed in a cool dark place. Water was applied over the container to prevent from drying. Casts were collected after 6 weeks after the introduction of the earthworms and nutrient content was analyzed for pH, N, P, and K.

Data Gathered

Physical properties of vermicompost

This was done by weighing 5 to 10 grams of freshly harvested vermicompost from each treatment. Samples were oven-dried at 70 degrees Celsius for 24 hours. Moisture content was calculated using the formula:

$$\%MC = (FW - ODW) / FW \times 100$$

Where:

MC= moisture content
FW= fresh weight of vermicompost (g)
ODW= overn-dry weight of vermicompost (g)

Chemical properties of vermicompost

Vermicast from each treatment was analysed for the following parameters: pH was determined using potentiometric method (PCARR,1980). Organic Matter (OM) was determined following the walkley-black method (Nelson and Sommers, 1982). Total Nitrogen (N) was derived using the equation:

$$\text{Total N (\%)} = \%\ OM \times 0.05$$

Total Phosphorus (P) was determined by using the extract from total K analysis, 2 ml aliquot of the extract from each treatment was placed in test tubes and was added with mixed reagent and stand for one hour to develop the molybdenum blue color. The sample was measured using B-L spectronic 20 at 880 nm and computed using the formula:

$$\text{Total P (\%)} = ODS \times K \times (100/0.05) \times (1/1000) \times \text{dilution}$$

Where:

ODS = optical density
K = slope of standard curve
100 = dilution of digested sample
1/10000 = to express result in % basis

Total Potassium (K) was determined suing Aqua Regia method (Chen and Lena, 2001).

Statistical Analysis

Statistical analysis of all data was obtained using the statistical tool available (CROPSTAT ver. 7.2.3) Analysis of variance (ANOVA) technique was used to compare the nutrient content of the different treatment use. Treatment means was separated following the Fisher Protected Least Significant Difference (FPLSD) at 5% level of significance.

RESULTS and DISCUSSION

Chemical Characteristics of Vermicompost Soil pH

Soil pH is a basic soil chemical property that affects many chemical and biological activities in the soil. Soil reaction can be alternatively known as soil pH which means the degree of acidity and alkalinity in a soil. The pH of the soil expresses the activity of hydrogen ions (H^+) in the soil solution. Moreover, mineral nutrients to plants can be affected by soil pH as well as many soil processes (FAO, 2006).

In terms of pH (Figure 1), treatment 3 which is a combination of cow manure, mudpress, banana peelings, and kudzu showed the highest pH or more alkaline among the other substrates. However, the pH value of all the substrates ranges from 7.66-7.92 which indicates a slightly alkaline condition. On the other hand, the pH value of all the vermicasts ranges from 6.85-7.12 which indicate a slightly acidic to near neutral condition. Among the vermicasts produced from different substrates, treatment 1 which is a combination of cow manure, mudpress, and banana peelings showed the highest pH or near neutral condition. In overall, there were slightly decreased in pH from its initial sample (substrate) to its final sample (vermicast). This could be attributed to the nature and properties of the substrate being used.

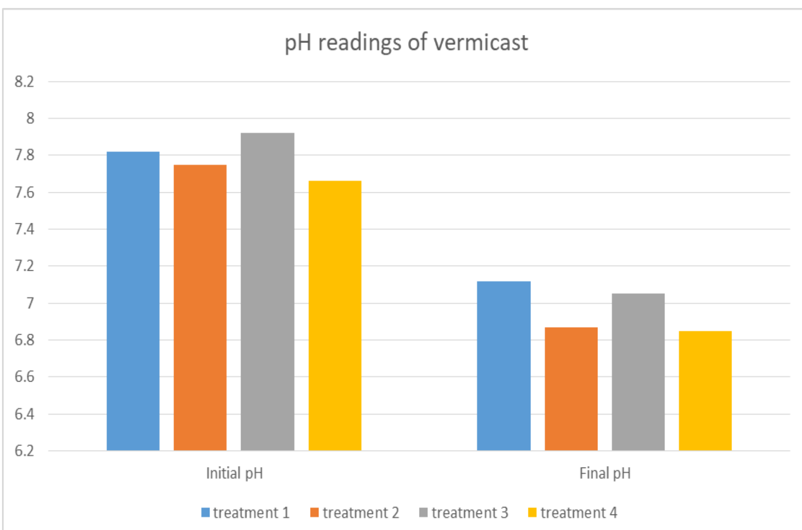

Figure 1. pH levels of vermicompost as influenced by varying substrates

Total Nitrogen

According to the results of the statistical analysis, the mean percent nitrogen of the four treatments of the initial samples was not significantly different from each other as shown in Figure 2. This means that the addition of leguminous plants to the substrate combination did not help increase the substrate's nitrogen content.

The final samples showed the same statistical analysis results with the initial samples. The treatments are also not significantly different from each other. When the initial samples (substrates) are compared to the final samples (vermicast), it can be seen that nitrogen content of the substrates decreased after it was converted into vermicast. Hand et al., (1988) has reported that nitrogen mineralization was greater in the presence of earthworms, and this mineral nitrogen retained in nitrate form. The reason for the lesser nitrogen content for the final samples might be due to the reason that the organic nitrogen was mineralized into nitrate form and might have leached or volatilized and some of the nitrogen was utilized by the worms for its growth and development.

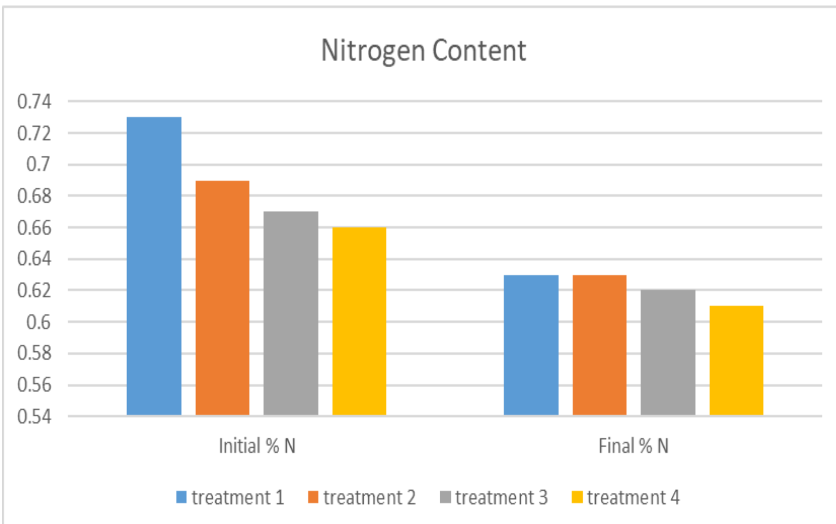

Figure 2. Total N (%) of vermicompost as influenced by varying substrates

Total Phosphorus

During the conduct of the study an initial sampling was implanted in order to measure the original levels of nutrients from the different substrates that will undergo vermicomposting. Readings from the results indicates that treatment 1 had the highest phosphorus content which was followed by treatment 4, treatment 2 and lastly from treatment 3 (Figure 3). Higher P readings of treatment 1 could be due to the higher cow manure and mud press content of the substrate. Ghosh et. al., (1998) reported that prior to vermicasting process, cow manure and mud press contain 1659.5 ppm mineral P and 2193.7 ppm mineral P, respectively. In addition, the organic P content in cow manure meAfter the vermicomposting process it was observed that there is a drastic decrease of P content of treatment 1 while the other treatments considerably increased in P content, with treatment 3 as the highest. Lazcano et al., (2008) reported that the process of vermicomposting resulted to a large decrease of available P.

The decrease of P of treatment 1 could be due to in growth and multiplication rate of the earthworms in the organic wastes, which resulted in a differential pattern of uptake of the nutrient for their body synthesis which caused a lesser release of the remaining P (Ghosh et al., 1998).

Leguminous plants such as kakawate have P levels that ranges from 0.19 to 0.25 based on the findings of Budelman (1989). Moreover, Kudzu appears to be largely dependent on mycorrhizal relationships. Plants from Alabama were found to develop 70% root colonization with mycorrhizal fungi, although only 10% of root tissues showed arbuscule development (Greipsson and DiTommaso, 2006). Inoculation of vesicular arbuscular mycorrhizal species resulted in higher tropical kudzu yields and greater magnesium and phosphorus uptake (Dodd et al. 1990). With these findings, it implies that both these leguminous plant species may contain high amounts of P. Increased P levels of treatments 3 and 4 may have been caused by the action of earthworms, which released higher amounts of phosphorus from the organic form and, at the same time, reduced fixation in different inorganically bound forms. Such effects of earthworms in mineralizing wide ranges of organic materials with the help of various bacteria and enzymes in the intestine has been described in detail by Edward and Lofty (1972). Mansell et al. (1981) showed that plant litter contained more available P after ingestion by earthworms and they attributed this increase to physical breakdown of the plant material by the worms. Satchell and Martin (1984) found an increase of 25% in total P of paper-waste sludge, after worm activity.

They attributed this increase in Total P to direct action of worm gut enzymes and indirectly by stimulation of the microflora. According to Lee (1992) the passage of organic residue through the gut of earthworm to the plant the released of phosphorus in available form is performed partly by earthworm gut phosphatases and further released of phosphorus might be attribute to phosphorus solubilizing microorganism present in worm cast.

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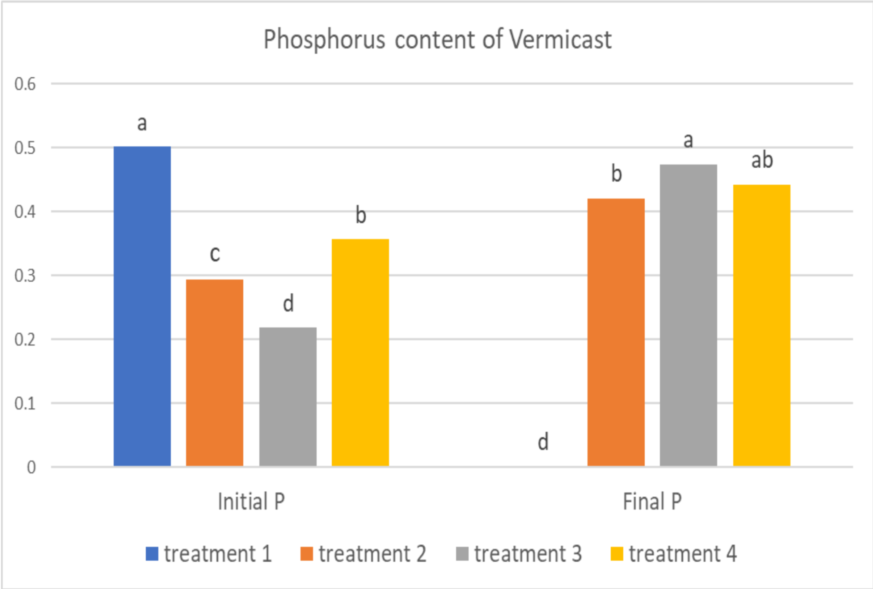

Figure 3. Total P (%) of vermicompost as influenced by varying substrates

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Total Potassium

The results indicated that there is statistically significant difference on treatment 4 compared to all treatments on both initial and final having a significant difference on total potassium analysis on the different vermicast as influenced by different substrates fed to the earthworm (Figure 4). The significant increase in potassium was also confirmated with the study of Basker et. al (1992) their study indicated that exchangeable K content increased significantly due to earthworm activity however extractable K did not change significantly, the statistically insignificant change in extractable K was expected since earthworms cannot increase the total amount of nutrients in the soil but can make them more available, and they may increase the rate of nutrients cycling.

The result of the current study indicated that the treatment 4 can increased the potassium content of the cast on the other hand treatment 1 & 3 is comparable to treatment during final analysis was observed having a value of 1.00 & 0.99 respectively while treatment 2 shows inferior results.

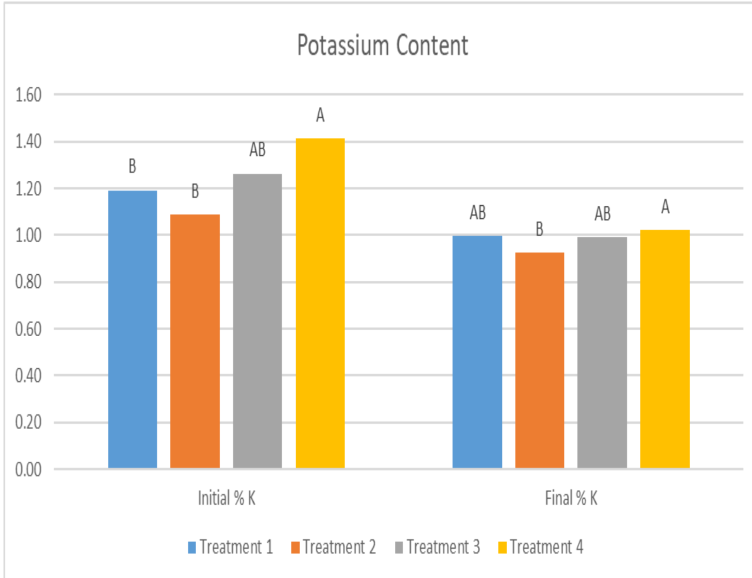

Figure 4. Total K (%) of vermicompost as influenced by varying substrates

CONCLUSIONS

Vermicompost can produce high quality organic fertilizers which are much better compared to other commercial fertilizers sold in the market. In addition, vermicomposting is a good strategy to reduce the intensive use of inorganic fertilizers, improve overall status of the soil, and increase crop yield and productivity. Based on the results of the study, the different substrates (initial sample) as well as the vermicasts (final sample) showed differences in terms of pH, total N, total P, and total K. Therefore, the following conclusions can be drawn:

1. Substrates and vermicasts among all treatments range from slightly acidic to slightly basic condition indicating as a good source of soil conditioners. N content for both substrates and vermicasts was not significantly different from each treatment. On the other hand, P content of vermicasts produced from varying substrates has considerably increased except for treatment 1. For total K, there were significant differences on different vermicasts as influenced by different substrates with vermi worms.
2. Thus, there were considerably decreased in terms of pH, total N, K from its initial sample (substrate) to its final sample (vermicast) except for total P. This could be attributed to the nature and properties of varying substrates fed to the earthworms.

RECOMMENDATIONS

1. Sufficient time should be allotted for the research to maintain the sustainability of vermicompost until harvesting of vermicasts and thus, having a reliable result.
2. It would be better if studies in the future can use and compare more leguminous plants as potential substrates that may increase N, P, K content of vermicasts.

Conflict of Interest

The authors would like to declare that there is no conflict of interests regarding this paper's publication. Hence, all authors are informed by the corresponding author before submission of this article for publication.

Authors' Contribution

This work was carried out in collaboration between the senior and junior authors. Both authors contributed to the conduct of the study up the final editing of the article before submission for publication.

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