Research article

Effect of Storage Duration in the Quality of Vermicompost

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Received 12 October 2013 Accepted 11 August 2014 (*Corresponding Author)

Abstract A trend of demand for organic products in both domestic and international has dramatically grown in both rate and expansion. Organic agriculture does not only provide rich nutrition and toxic free soil but is also have low in production cost. The use of vermicompost is an alternative way to add organic material in farming and alter the soil properties in a positive way; for instance, by increasing the soil nutrient availability. To make use of vermicompost efficiently, it is important to recognize that the quality of the vermicompost may change due to the duration of its storage. This study utilized vermicompost, which had been maintained for different periods (0, 1 and 3 months) to study changes in its biological and chemical qualities. The study found that the amount of living bacteria and fungi when storing the vermicompost at a 1 month period and the storage would remain stable until the third month. The changes in soil chemistry indicated that the pH and EC values decreased during storage in the first month from 8.53 to 7.50 and from 1.25 ds/cm to 0.84 ds/cm respectively, and increased again during storage in the third month, which were 8.33 and 2.18 ds/cm respectively. The changes in amount of nutrients indicated that nitrogen (TN) and calcium (Ca) were not different throughout the storage period of three months. On the other hand, the amounts of potassium (TK) and magnesium (Mg) decreased during storage in the first month and increased in the third month whereas the amount of phosphorus (TP) increased during the first month of storage period and stabled in the third month. The changes in both biological and chemical parameters proved that the vermicompost could be kept up to 3 months with good quality.

Keywords vermicompost, storage, chemical and biological properties

INTRODUCTION

The trend of demand for organic products in both domestic and international agriculture has increased by a 20 growth rate of percent per year due to the fact that manufacturers and consumers in turn pay much more attention to hygiene, safety, and environmental pollution (Somkhit, 2006). Organic agriculture is a farming system that uses the principles of the ecological balance of natural application to manage agricultural production by incorporating biodiversity of crops, livestock, forestry, fisheries etc. in a supportive and renewable resource in the ecosystem for maximum benefit and by avoiding using inputs imported from outside the farm. This includes the use of synthetic chemical inputs such as fertilizers, pesticides, hormones, antibiotics, etc. In addition, organic agriculture provides high yielding soil, rich nutrient and non-toxic together with low production cost. Using vermicompost is another alternative input in organic farming. The use of vermicompost in the planting phase will result in better soil structure and is also efficient with water and air drainage, greater moisture retention and creates incoherency in soil so that plant roots can thread and spread widely (Edwards et al., 2011). Vermicompost provides a greater variety of microorganisms than in other normal compost. These microbes act to decompose detritus into useful organo-nutrients for plant growth. Compost and worm tea have humic acids which contain nutrients that are essential to many plants such as phosphorus (P), potassium (K), calcium (Ca), iron (Fe), and copper (Cu) and will be released when needed by plants.

Production of vermicompost is a simple technological process, which uses a mixture of organic sludge with earthworms to change the composition of the waste and produce the bio-modified materials that are useful for crops (Iwai et al, 2013). Vermicompost possesses a moldy-grain, fine, brown, and light characteristic material; but its quality inevitably changes with time. In order to obtain optimum efficiency, it is thus important to know how the quality of vermicompost may change due to different storage times.

OBJECTIVE

The aim of this study is to follow and understand the change in quality of vermicompost due to the duration of its storage

METHODOLOGY

The study was conducted at the Center for Learning and Development of Earthworms for Agriculture and Environment Faculty of Agriculture Khon Kaen University. To explore the scope of vermicomposting and sampling vermicompost, the vermicompost produced from *Eudrillus eugeniae* worm species commonly called the African Night Crawler were fed a blend of cassava waste, soil, and cow dung at 7:2:1 ratio. The vermicompost was filled into polypropylene woven bags which were bound tight. The bags were kept in room at a temperature range of 24°C to 35°C with no humidity control, for storage periods of 0, 1, and 3 months, for 3 repetitions each before sampling for analysis of chemical and biological properties. The completed randomize design experiment is used for analysis of variance of the data (analysis of variance) and analysis of the difference between the mean by DMRT (Duncan's Multiple Range Test)

Table 1 Chemical properties of individual blend based used in vermicomposting

Properties	Cassava waste	Cow dung	Soil (sandy soil)
pH	4.95	9.20	5.0
EC (mS/cm)	0.67	3.57	0.35
Organic Matter (OM %)	78.88	54.25	0.45
Total nitrogen (% N)	0.24	1.35	0.021
Total phosphorus (% P)	0.025	0.664	0.008
Total potassium (% K)	0.36	0.495	0.121

Analysis of Chemical Properties

The study of some chemical properties was carried out in the laboratory at the Development and Monitoring Crop and Inputs Group, the Office of Agricultural Research and Development Region 3 Khon Kaen province has analyzed the chemical properties. The pH was measured using a pH meter with a 1:2 ratio of fertilizer to water, electrical conductivity (EC) by using an electrical conductivity meter, total of nitrogen (total N) by using the Kjeldahl method, total phosphorus (total P_2O_5) by using the spectrophotometric molybdovanadophosphate method, total of potassium (total K_2O) by using the flame photometric method and the total calcium (Ca) and magnesium (Mg) by using atomic absorption spectroscopy.

Analysis of Biological Properties

Fungi: The samples of vermicompost are put into the Erlenmeyer flask with 90 mL of sterile distilled water before shaking off the microbes and leaving the sediments to settle. Concentration of the samples is 10^{-1}. The samples are further diluted with sterile distilled water to obtain 10^{-2} and 10^{-3} concentrations. The diluted soil solution is then taken for a spread plate technique on the rose Bengal-streptomycin agar supplemented with streptomycin antibiotic of 30 μg/ml concentration. The dilution is made 3 times with repetitions of each before being fermented at 30 °C for 5-7 days

and counting all organisms.
Bacteria: Ten grams of vermicompost samples are put into the Erlenmeyer flask with 90 mL of sterile distilled water before shaking off the microbes (mixed with sterile distilled water) and leaving the sediments to settle. Dilution of water samples with sterile distilled water is carried out to obtain 10^{-3}, 10^{-4}, and 10^{-5} concentrations. The diluted solution is then taken for a pour plate technique by using the soil extract agar. The dilution is made 3 repetitions each before being fermented at room temperature for 3 days and counting all microorganisms.

RESULTS AND DISCUSSION

Chemical Quality Changes at Different Storage Periods

The vermicompost has the following retention periods: 0 (new fertilizer), 1 and 3 months. The results of chemical analysis are shown in Table 2 below.
Acidity and alkalinity (pH): The pH values decreased in the first month and increased in the third month. The decrease in the first period may be caused by the activities of microorganisms, which are greater in number and relatively to its increasing population. These activities cause acid to occur such as via the nitrification process or mechanism for changing potassium into a soluble form. However, again, the increase in the third month is because of higher amounts of calcium and potassium.
Electrical conductivity (EC): The EC values provided the same analysis results as the pH. The decreased in the first month from 1.25 to 0.84 and again increasing in the third month period from 0.84 to 2.18 may be due to the amount of increasing microorganisms which was affected to the decomposition of organic matter results in an increasing of ion causing the EC values to rise.
Total of potash (T-K_2O): The total of T-K_2O provides a decrease in the first month but increasing in the third month as observed for pH and EC. The increase of EC from 0.63 to 1.13 may be due to the amount of increasing microorganisms. Some groups of microorganisms may produce microbial acid which is the proper pH value in primary mechanism for changing potassium into the soluble form (Payal et al, 2005).
Total of phosphorus (T-P_2O_5): The amount of T-P_2O_5 increased in the first month from 0.30 to 0.66 due to pH value being in the proper range for changing into soluble form. However it decreased in the third month from 0.66 to 0.30 which is to the same at new fertilizer. The reduction may be due to the immobilization. Amount of increasing microorganisms in the compost takes phosphorus in greater quantities for growth.
Total of nitrogen (TN): The TN values slightly increase from 0.33 to 0.47 but not differ statistically during the study. However increased value indicates that there is nitrogen fixation, a process of combining atmospheric nitrogen with other elements to form useful compounds. In nature, nitrogen is fixed by some microorganisms and by lightning, so the greater number of microorganisms in the third months made TN values rise.
Magnesium (Mg) and calcium (Ca): The amount of magnesium decreased in the first month from 0.27 to 0.22 but increased later in the third month period from 0.22 to 0.31 like Ca slightly increased in the third month from 0.65 to 0.68. The changing of values is an affected of greater number of microorganisms, relate to nutrient release from organic matter (mineralization).

Table 2 Chemical properties of vermicompost at various storage periods

Periods of storage	pH	EC (ds/cm)	TN (%)	T- P_2O_5 (%)	T- K_2O (%)	Ca (%)	Mg (%)
0 (New fertilizer)	8.53 a	1.25 b	0.33	0.30 b	0.97 b	0.65	0.27 b
1 month	7.50 c	0.84 c	0.43	0.66 a	0.63 c	0.65	0.22 c
3 monthes	8.33 b	2.18 a	0.47	0.30 b	1.13 a	0.68	0.31 a
F-Test	**	**	ns	**	**	ns	**
Coefficient of variation %	0.58	4.8	19.86	7.89	6.34	8.17	3.73

Note: Mean (n=3) in the same column followed by the same lower case letters are not significantly different at $p \leq 0.05$

Biological Quality Changes at Different Storage Periods

The results from analysis of biological properties showed that the number of fungi and bacteria has increased more in the first month of storage. This may be due to microbial activities that are still on going after fermentation ends. However, when stored for a period of three months, the amounts of fungi and bacteria do not differ from the first month. This may be a result of the activity called extracellular enzyme when storing or fermenting the vermicompost. The first step was characterized by a decrease in microbial populations, which resulted in a reduction in the synthesis of new enzymes. The second step was the degradation of the pool of remaining enzymes (Manuel et al, 2007) as shown in Table 3.

Table 3 Biological properties of vermicompost at various storage periods

Periods of Storage	Number of microorganisms (cfu/g)	
	Bacteria	Fungi
0 (New fertilizer)	2.67×10^{6} b	2.67×10^{2} b
1 month	4.00×10^{6} a	4.00×10^{2} a
3 monthes	4.00×10^{6} a	4.67×10^{2} a
F-Test	**	**
Coefficient of variation %	9.38	12.48

Note: Mean (n=3) in the same column followed by the same lower case letters are not significantly different at $p \leq 0.05$

CONCLUSION

The study on the quality change of vermicompost is the study of changes in chemical and biological properties of vermicompost preserved in different periods (0, 1 and 3 months). It was found that the chemical properties of the vermicompost are changing differently, and yet there is no clear trend in the changes of pH, EC, total potash and magnesium. Magnesium decreased in the first period of storage and increased again in later periods while the total nitrogen and total calcium were not significantly different throughout the study. For biological properties, it was found that the numbers of fungi and bacteria were greater in the new stored compost. However, there is no difference in the amount when storing at 1 and 3 months. These results showed that microbial activities had still continued. Therefore, it can be concluded that the fertilizer stored for 3 months is still in the good quality.

ACKNOWLEDGEMENTS

This research project was funded by The National Research Council of Thailand (NRCT) and National Science and Technology Development Agency (NSTDA), Integrated Water Resource Management Research and Development Center in Northeast Thailand, The Research Developing and Learning Centre on Earthworm for Agriculture and Environment and Groundwater Research Centre, Khon Kaen University, Thailand. Thanks are extended to the Division of Land Resource and Environment, Faculty of Agriculture, Khon Kaen University for the support and equipments in laboratory test. Thank you to Prof. Barry Noller for his kind editing of the manuscript.

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