Research article

Using Chicken Manure in Vermicompost to Manage Different Agro-Industrial Wastes

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Abstract The agro-industrial waste has been increasing every year. Without proper management, it would cause problems to soil as well as water and air pollution to the environment. Thus, the objective of this study was to investigate the use of chicken manure in vermicompost of agro-industrial waste. The vermicompost experiment was conducted by using different agro-industrial wastes (cassava pulp, cassava peel, eucalyptus peel and oil palm) and different rates of chicken manure (2.5%, 5%, 10%, 15%, 20%, and 25%). The qualities of each mixture and vermicompost in different treatments before and after 30 days were analyzed. Earthworms (*Eudrilus eugeniae*) could survive 100% in the vermicompost of chicken manure at the rate of 2.5 - 25% in cassava pulp, cassava peel and eucalyptus peel treatments, but could not survive in the oil palm treatment. After 30 days, the growth of earthworms in the vermicompost treatments with cassava pulp, eucalyptus peel, cassava peel with chicken manure were increased at 134%, 188% and 167%, respectively. Therefore, chicken manure can be used to increase the growth of earthworms in vermicompost using industrial wastes (cassava peel, cassava pulp, and eucalyptus peel) to produce biofertiliser and reduce environmental pollution problem.

Keywords chicken manure, earthworm, vermicompost

INTRODUCTION

The economy of Thailand is greatly expanding nowadays at the expense of natural resources. An Agro industry, in particular, has consumed raw materials from those resources for production. With industrial processes, there are byproducts of colossal wastes that pollute soil, water, and air. Moreover, the large amounts of agro-industrial wastes produced bring about impact on our environment and nature. Without proper management or the wastes are too great a quantity to handle, the environment problems will be increasing. Furthermore, chicken manure is a cause of environmental impact that highly pollutes the soil, water and air (Tacon, 1991). The problem doubles during the rainy season when floodwater leaches the wastes to soil down into canals or rivers. This affects every life that lives in soil and water. One way to manage organic wastes is using earthworms to handle industrial wastes (Iwai et al., 2011; TonsCho, 2010).

Using earthworms does not cost a lot of money for waste treatment and does not disturb nearby communities because manure from sludge waste can produce good vermicompost and earthworms transform the sludge to a good fertilizer (Suthar, 2007). Vermitechnology is a type of compost production from earthworm activities and the product is vermicompost, a solid that

includes vermicast and worm casting, decomposed organic fossil, and vermin-juice which is liquid from the earthworm and the fermentation process. Liquid is used in the production and liquid from the fermentation process is used to make manure (Iwai et al., 2011).

Chicken manure is an agro-waste that is filled with essential minerals which are important for plant growth (Garner, 1966; Edwards, 1988). When chicken manure is mixed with organic materials from many agro-industrial factories, vermicompost is the outcome. Vermicompost speeds up the growth rate of earthworms. Hence, we were interested to study the use of chicken manure in vermicompost production to manage agro-industrial wastes.

OBJECTIVE

This study was aimed at investigating the use of chicken manure in vermicompost to manage different agro-industrial wastes.

MATERIAL AND METHODS

Chicken manure makes good nutrient for earthworms that in turn increase the rate of compost production. Our study comprised 4 trials of chicken manure blending: 1) with cassava pulp, 2) with cassava peel, 3) with eucalyptus peel, and 4) with oil palm.

Each agro-industrial waste was mixed with sandy soil (Yasotorn soil) by using 70:30 ratio and the mixture blended with chicken manure at the rates of 0, 2.5, 5, 10, 15, 20 and 25% by weight. The earthworm used in this trail was *Eudrillus eugeniae s*pecies; its common name is African Night Crawler.

The experimental materials, namely, chicken manure, cassava peel, cassava pulp, eucalyptus peel and sandy soil were dried indoor for specific ratios of weight. Earthworms were selected based on similar size and explicit maturity based on Clitellum (System of propagation species). The moisture content of materials for feeding earthworms was maintained at 50% throughout the study.

Data was collected by recording the rates of survival of earthworms and their weights before and after the experiments.

Table 1 Chemical characteristics of agro-industrial degradation (chicken manure, cassava pulp, cassava peel, eucalyptus peel and oil palm)

Chemical characteristics	Natural Organic Adsorbents				
	cassava pulp	cassava peel	eucalyptus peel	oil palm	chicken manure
Hydrogen ions (pH)	4.95	5.45	7.47	5.32	8.80
Electric conductivity (EC)	0.67	1.25	0.34	5.92	6.20
Organic matter (OM %)	89.57	58.00	38.96	78.11	24.50
Total nitrogen (% N)	0.24	0.49	0.25	0.92	1.50
Available phosphorus (% P)	0.02	0.05	0.08	0.41	5.10
Extractable potassium (% K)	0.36	0.51	0.18	1.23	2.40
C/N ratio	220.87	69.05	89.64	45.03	9:1

RESULTS AND DISCUSSION

The survival rates of earthworms when using chicken manure blended with agro-industrial wastes

The usage of cassava pulp blended with chicken manure: Earthworms could survive 100% in various ratios of blending cassava pulp with chicken manure (0, 2.5, 5, 10, 15, 20, and 25% by weight). However, the usage of chicken manure at the highest rate of 25% blended with cassava pulp did not affect the rate of the survival of earthworms after 30 days. This suggests that application of chicken manure at an optimum rate could increase reproductivity of earthworms. Nevertheless, over-dose rate use of chicken manure could decrease earthworm growth. This

resulted from high EC or salinity which was not suitable for earthworm living. Our result was consistent to the report of the Department of Public Work, Los Angeles County (2002) which stated that in environment with high organic matter content, growth rate of juvenile *L. rubellus* was better than *E. eugeniae*.

The usage of eucalyptus peel blended with chicken manure: Earthworms could survive 100% in various ratios of blending eucalyptus peel with chicken manure (0, 2.5, 5, 10, 15, 20, and 25% by weight). Similarly, the usage of chicken manure at the highest rate of 25% blended with eucalyptus peel did not affect the rate of the survival of earthworms after 30 days (Mertus, 1993). Earthworms are very sensitive to pH or H^+ changes. Normally, earthworms can exist in environment that has pH ranging from 4.2 - 8. However, pH 7 is the most suitable for earthworms (Edwards and Bohlen, 1996).

The usage of cassava peel blended with chicken manure: Earthworms could survive 100% in various ratios of blending cassava peel with chicken manure (0, 2.5, 5, 10, 15, 20, and 25% by weight). It was shown that the usage of chicken manure at the highest rate of 25% blended with cassava peel did not affect the rate of the survival of earthworms after 30 days. This can be explained by higher electrical conductivity (EC) or salinity of the compost (Edwards and Bohlen, 1996). In addition, raw materials used in this study mainly contained organic nitrogenous compounds that can be easily decomposed, which resulted in releasing large amount of NH_4^+ contributing to rapid pH increase that influenced earthworm existence.

The usage of oil palm blended with chicken manure: Earthworms could not survive in various ratios of blending oil palm with chicken manure (0, 2.5, 5, 10, 15, 20, and 25% by weight). Although it did not have chicken manure (0%), the result showed that the oil palm blended with earthworm feed and chicken manure could not make the earthworms survive even for a short time of just 1 week. This can be explained by higher electrical conductivity (EC) or salinity of the compost (Edwards and Bohlen, 1996). In addition, raw materials used in this study contained mainly organic nitrogenous compounds that can be easily decomposed, which resulted in releasing large amount of NH_4^+ that contributes to rapid pH increase influencing earthworm existence. (Mertus, 1993).

The growth of earthworm when using chicken manure blended with agro-industrial wastes

The usage of cassava pulp blended with chicken manure: The blending of cassava pulp with chicken manure at 5% rate resulted in increased weight of earthworms (2.32 g). The highest weight of earthworms at 134% was changed from when earthworms were fed 1 month ago. They became heavier than at the blending rates of 0, 2.5, 10, 15, 20, and 25%, or an increase of 22, 85, 105, 50, 35.4 and 11.8%, respectively (Fig. 1 and Fig. 2). Edwards and Lofty (1972) found that organic matter content was a crucial factor affecting earthworm weight. In this study, cattle manure vs. other materials added with P, K, Na, and Mg were compared for vermiculturing. It was found that weight of earthworms cultured in cattle manure increased more than 75%.

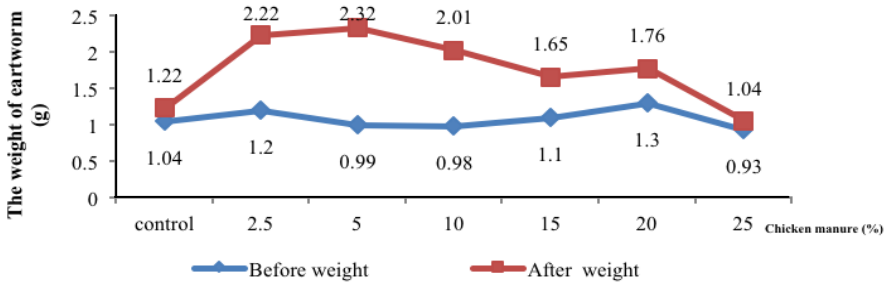

Fig. 1 The weight of earthworms (g) while using of the cassava pulp blended with chicken manure by ratios after 30 days

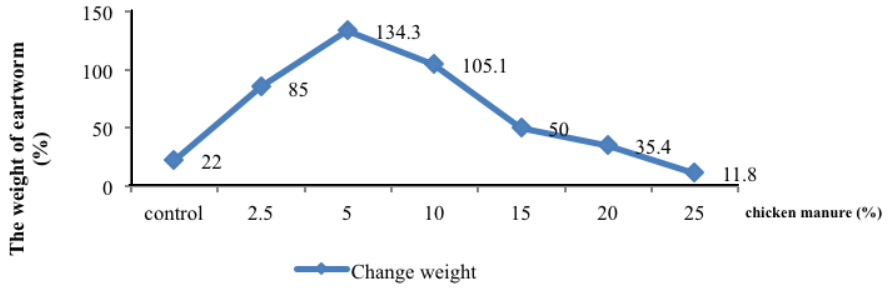

Fig. 2 Change of the weight of earthworm (%) before and after experiment by using the cassava pulp blended with chicken manure by ratios after 30 days

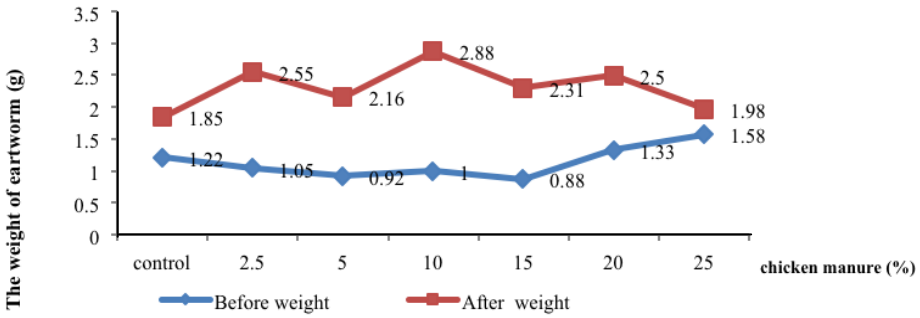

Fig. 3 The increasing of the earthworm's weight (g) while using cassava pulp blended with chicken manure by ratios after 30 days

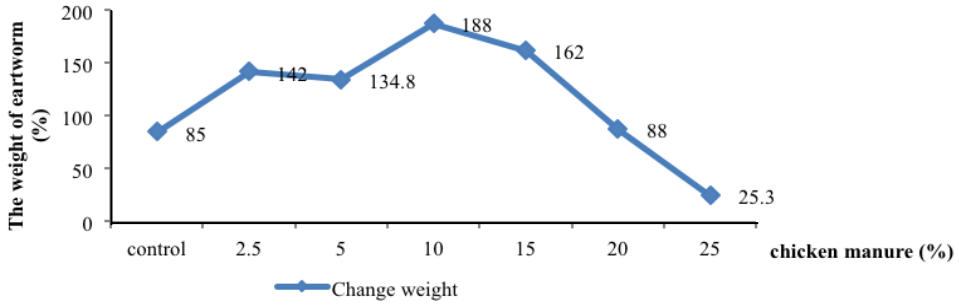

Fig. 4 Change of the weight of earthworms (%) before and after experiment while using cassava pulp blended with chicken manure by ratios after 30 days

The usage of eucalyptus peel blended with chicken manure: The blending of eucalyptus peel with chicken manure at 10% rate showed an increase in the weight of earthworms (2.88 g). The highest weight of earthworms at 188% was changed from when earthworms were fed 1 month ago. They were heavier than when the rates were 0, 2.5, 5, 15, 20, and 25%, an increase of 85, 142.9, 134.8, 162.5, 88 and 25.3 %, respectively, as shown in Fig.3 and Fig.4. This might be caused by high EC, salinity (Edwards and Bohlen, 1996), and pH values resulting from release of NH_4^+ from labile organic nitrogenous compounds were not suitable for earthworm existence (Mertus, 1993).

The usage of cassava peel blended with chicken manure: The blending of cassava peel with chicken manure at 2.5% rate increased in the weight of earthworms (2.94 g). The highest weight of earthworms at 167% was changed from 1 month ago; the weight was higher than at the blending rates of 0, 5, 10, 15, 20, and 25%, or an increase of 124, 91.5, 88.2, 35.8, 34, and 27.7 %, respectively (Fig. 5 and Fig. 6). This is consistent with Kwansod (2003) who reported that using low ration of chicken manure led to high potential transformation of nutrients in raw materials in earthworm biomass.

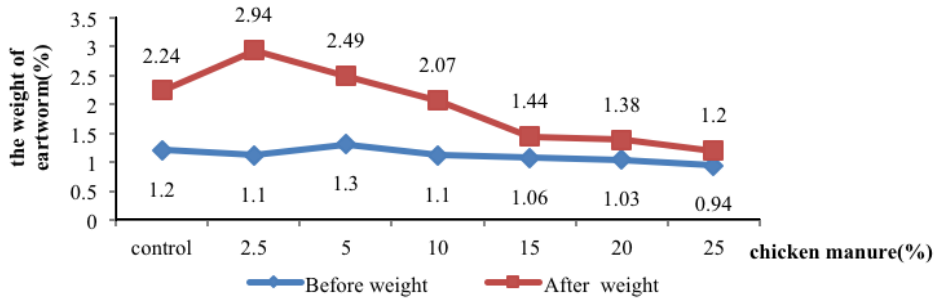

Fig. 5 The increasing of the earthworm's weight (g) while using cassava pulp blended with chicken manure by ratios after 30 days

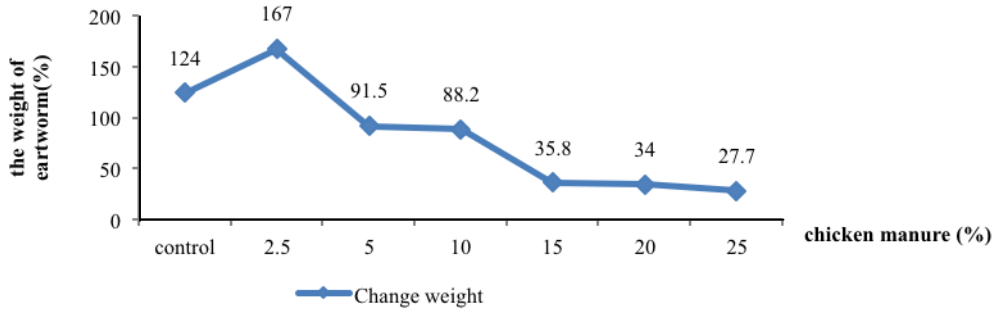

Fig. 6 Change of the weight of earthworm (%) before and after experiment while using cassava pulp blended with chicken manure by ratios after 30 days

CONCLUSION

The survival of earthworm when using chicken manure blended with agro-industrial wastes

The usage of chicken manure in all ratios (0, 2.5, 5, 10, 15, 20, and 25% rates) blended with cassava pulp, cassava peel, and eucalyptus peel can increase % survival of the earthworms at 100% after 30 days. The chicken manure of the highest rate at 25% by weight with oil palm blended did not make the earthworms survive; not even without chicken manure (0% rate). With time proceeded, EC and salinity of vermicompost influenced earthworm survival. Edwards (1988) reported that high salinity of the compost could reduce earthworm growth. Generally, the optimum EC or salinity for earthworm survival ranges from 1.58 to 3.35 dSm^{-1} (Owojorl et al., 2008).

The growth of earthworm when using chicken manure blended with agro-industrial wastes

The usage of chicken manure at 5, 10 and 2.5% with cassava pulp, eucalyptus and cassava peel, peel, respectively, better increased the weight per body than other chicken manure ratios. This shows that use of optimum rate of chicken manure could increase earthworm biomass. However, employing over-dose rate (> 10%) of this material contributes to decrease in earthworm weight. Our results suggest that poultry manures such as chicken manure are not suitable for vermiculture. This is likely because these manures contain enriched ammonia and inorganic salts in which earthworms cannot survive. However, if ammonia and inorganic salt contents can be reduced, chicken manure is very appropriate for vermiculture. This is because chicken manure has a number of nutrients, which can increase the compost value. (Edwards, 1988)

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REFERENCES

Department of Public Work, Los Angeles County. 2002. Types of worms. (http://smartgardning.com/types of worms. htm. accessed March 15, 2013.)

Garner, H.V. 1966. Experiments on the direct, cumulative and residual effect of town refuse manure and sewage sludge at Rothamated and other. J. Agir. Sci., 67, 223-233.

Iwai, C.B., Ta-oun, M., Seripong, S. and Champar-ngam, N. 2011. Vermicomposting: good management practice for waste, soil and yield safety. Department of Plant Sciences and Agricultural Resources, Land Resources and Environment Section, Faculty of Agriculture, Khon Kean University, Thailand. 171.

Edwards, C.A. 1988. Breakdown of animal, vegetable and industrial wastes by earthworms. SPB Academic Publishing, Netherlands. 268.

Edwards, C.A. and Bohlen, P.J. 1988. Breakdown of animal, vegetable and industrial wastes by earthworms. SPB Academic Publishing, Netherlands. 268.

Edwards, C.A. and Burrows, I. 1996. Biology and ecology of earthworms. Chaman and Hall, London, UK. 142-145.

Edwards, C.A. and Lofty, J.R. 1972. Biology of earthworms. Bookworm publishing Company.

Kwansod, T. 2003. Treatment and vermicomposting of chicken manure using *Lumbricus rubellus* and *Eudrilus eugeniae*. Master of Science (Agriculture). Department of Animal Science, Kasetsart University, Bangkok. Thailand.

Mertus, J. 1993. Earthworms. (http://www. Mertus.org/gardening/worms/html. accessed March 15, 2013.)

Owojori, O.J. Reinecke, A.J., and Rozanav, A.B. 2008. Effects of salinity on partitioning, uptake and toxicity of zinc in the earthworm *Eisenia fetida*. Soil Biology and Biochemistry, 40, 2385-2393

Tacon, A.G.J. 1991. Standard methods for the nutrition and feeding of farmed fish and shrimp. Redmond, Washington, USA.

TonsCho, A. 2010. Producing fertilizer from organic waste with earthworms. Department of Soil and Environment, Faculty of Agricultural Production. Maejo University. Thailand.

Ta-oun, M. 2007. Techniques and analysis in the laboratory of soil, water and fertilizer. Department of Land Resources and Environment. Faculty of Agriculture. Khon Kaen University, Khon Kaen, Thailand.

Suthar, S. 2007. Microbial and decompositing efficiencies of monoculture and polyculture vermieactors based on epigeic and anecic earthworms. Word J. Micro Biol. Biotechnol., Doi: 10.1007/511274-007-9635-9.