Research article

Effect of Organic Materials from Agro-Industrial Wastes (Molasses and Distillery Slop) on Earthworms under Vermicomposting Using Cassava Waste

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Abstract The increasing of waste nowadays necessitates agro-industrial waste management, and vermicomposting technology has been offered as a viable method. However, before application of this method, a study of the effects of waste on earthworms is required. The objective of this study is to investigate the effects of organic material on earthworms as a result of the vermicomposting process. The experiment was conducted using completely randomized design with three replications. A toxicity test was administered to determine the effects of organic material (molasses and distillery slop from cassava industrial wastes) on the survival and growth of earthworms in vermicompost. The study found that after 7 days, 100% of the earthworms could survive under concentrations of molasses at rates of 1.25 - 3.75% and concentrations of distillery slop at rates of 6.25 - 25%. In addition, the application of organic materials (molasses and distillery slop) mixed with cassava industrial wastes increased the growth of earthworms. The earthworms had a survival rate of 67-100% after 4 weeks in the vermicompost treatment when molasses was mixed with cassava pulp and cassava peel, but without cassava pulp and cassava peel, the earthworms could not survive. Similar results were found with the application of distillery slop mixed with cassava pulp and cassava peel. Therefore, suitable rates of molasses and distillery slop use for earthworm survival are 1.25 - 3.75% and 6.25-25%, respectively. In conclusion, molasses and distillery slop can be used with cassava industrial waste material in the vermicomposting process.

Keywords organic material, earthworms, vermicompost

INTRODUCTION

Agro-industry has been expanding rapidly in developing countries in order to serve peoples' consumption. This expansion and its effects on the production process have led to increasing amounts of industrial wastes and environmental pollution. Vermicomposting technology was recently offered as a viable method for organic waste management. After decomposition of waste by earthworms, vermicompost is useful for agricultural sectors (Toncho, 2007; Iwai et al., 2011). The use of earthworms for organic waste management is considered a brilliant means for decomposition as their use is convenient and low cost. Vermicompost can be developed as high quality fertilizer and changes of chemical, physical and biological properties can be implemented. In addition, it has been found that vermitechnology produces more nutrients: 26-82% nitrogen, 90-94% phosphorus and 26-75% potassium (Iwai et al., 2011). Organic carbon is a food source that increases the growth and reproduction of earthworms and microorganisms in compost and is an important factor for organisms. A lot of molasses and distillery slop, currently, has been produced

from the sugar and ethanol industries.

OBJECTIVES

The objectives of this study are to investigate the effects on earthworms (*Eudrillus eugeniae*) of using organic material from agro-industrial wastes (molasses and distillery slop) for vermicomposting using cassava waste; to determine effects on the growth of earthworms; and to analyze the quality of vermitechnology fertilizer.

METHODOLOGIES

A toxicity test of organic material (molasses and distillery slop) to determine its effects on the survival of earthworms

A toxicity test of organic material (molasses and distillery slop) to determine its effects on the survival of earthworms was performed with concentrations of molasses at 1.25%, 2.5%, 3.75% and 5% and concentrations of distillery slop at 6.25%, 12.5%, 18.75% and 25% for a period of seven days. Earthworms (*E. eugeniae*) used for this study were obtained from Research Developing and Learning Centre on Earthworm for Agriculture and Environment. Adult earthworms (*E. eugeniae*) of weights ranging from 0.34 - 0.45 g and lengths ranging from 15 - 18 cm were placed in plastic containers divided into two sides with five earthworms per section. The control side was filled with 100 g dry weight of soil without contaminant and the other half of the plastic container was filled with organic material (molasses and distillery slop) in different concentrations with 100 g dry weight of soil. Survival rate of earthworms was observed and data was recorded every day.

A study of the survival and the growth of earthworms as affected by organic materials (molasses and distillery slop) mixed with cassava industrial wastes

This study included 4 sub-experiments with 4 different organic material combinations: 1) Molasses mixed with cassava pulp; 2) Molasses mixed with cassava peel; 3) Distillery slop mixed with cassava pulp; and 4) Distillery slop mixed with cassava peel. The ratio of cassava industrial wastes to soil to cow dung was 7:2:1. In each experiment, this ratio was mixed with concentrations of molasses at rates of 1.25%, 2.5%, 3.75% and 5% and concentrations of distillery slop at rates of 6.25%, 12.5%, 18.75% and 25%. This experiment used Completely Randomized Design (CRD) with three replications. Adult earthworms (*E. eugeniae*) of weights and length ranging from 0.34-0.45 g and length 15 cm-18 cm were released into plastic pot containers containing 100 g dry weight of soil with five earthworms per container. All the containers were kept at a temperature of $25 \pm 3\ ^{\circ}C$. The moisture content was maintained at 60–70% during the study period. Survival rates and weights of the earthworms were recorded before and after 30 days.

Statistical analysis: Differences among the treatments were assessed with analysis of variance using STATISTIC 8.

Table 1 Chemical characteristic of organic wastes

Parameters	Type organic wastes			
	Cassava pulp	Cassava peel	Molasses	Distillery slop
pH	4.95	5.45	4.9	4.51
EC (mS/cm)	0.67	1.25	8.18	30.85
Organic matter (%)	89.57	58	-	-
Total nitrogen (%N)	0.24	0.49	0.94	0.45
Phosphorus (%P)	0.025	0.051	0.18	0.043
Potassium (%P)	0.36	0.51	3.91	1.688

RESULTS AND DISCUSSION

A toxicity test of organic material (molasses and distillery slop) to determine its effects on the survival of earthworms

Toxicity tests of the various concentrations of molasses to determine its effects on the survival of earthworms found that 100% of earthworms could survive under molasses concentrations of 1.25 - 3.75%, but 73.3% of earthworms could survive under molasses concentrations of 5 %. In addition, the results of the different concentrations of distillery slop found that after 7 days of testing, 100% of earthworms could survive under concentrations of 6.25 - 25%. According to Toncho (2006), *E. eugeniae* can survive at pH 7.0 - 8.0, but molasses has a low pH of 4.9. It also has a high electrical conductivity (EC) of 8.18 (Sharma et al., 2007), which is considered to be very salty. Distillery slop was found to have an EC of 30.85 mS/cm, higher than molasses, but the earthworms could survive because the pH was decreased to neutral by fermentation (Pundee**,** 2006).

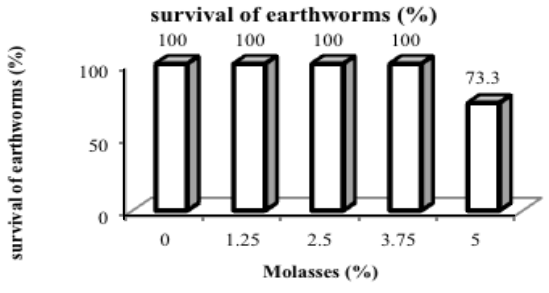

Fig.1. The % toxicity test of molasses on the survival of earthworms

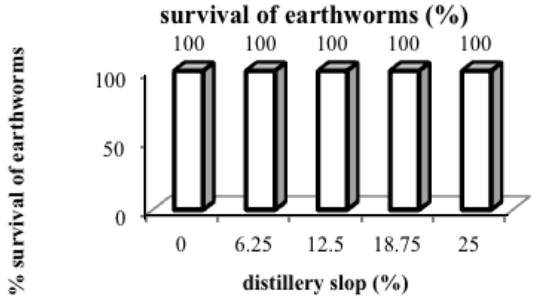

Fig.2. The % toxicity test of distillery slop on the survival of earthworms

A study of the survival and the growth of earthworms as affected by organic materials (molasses and distillery slop) mixed with cassava industrial wastes

The use of molasses mixed with cassava pulp and cassava peel: The results of both the use of molasses mixed with cassava pulp and mixed with cassava peel demonstrate that earthworm survival decreases with increasing rates of molasses concentration. After 4 weeks, 100% of earthworms could survive under molasses concentrations of 1.25% mixed with cassava pulp. Earthworms could not survive under concentrations of 5 % molasses. On the other hand, the study found that 100% of earthworms could survive molasses mixed with cassava peel under molasses concentrations between 1.25 - 2.50% but under molasses concentrations of 3.75 - 5 %, earthworm survival decreased to 55.56 - 33.33%. In other words, earthworms could survive under molasses mixed with cassava peel at higher rates than molasses mixed with cassava pulp. The cassava peel may have absorbed the molasses which would have decreased the toxicity of molasses (Cleasby, 1963). Earthworms could not survive 100% because the molasses has a high electrical conductivity (EC) of 8.18 mS/cm and a low pH of 4.9 (Pundee, 2006). According to Toncho (2006), *E. eugeniae* can survive at pH 7.0 - 8.0, so these characteristics of molasses are not conducive to the survival of earthworms.

The use of distillery slop mixed with cassava pulp and cassava peel: The results of the use of distillery slop mixed with cassava pulp and cassava peel showed that earthworm survival decreases with increasing rates of distillery slop concentration. After 4 weeks, 77.78% of earthworms could survive under concentrations of 6.25 - 12.5% of distillery slop. Under distillery slop concentrations of more than 18.75%, earthworms could not survive 100% because the distillery slop had a high electrical conductivity (EC) of 30.85 mS/cm and a low pH of 4.51 (Soongsud, 2008). The pH of cassava pulp was measured at 4.95 which is not conducive to the survival of earthworms. The use of distillery slop mixed with cassava peel found that earthworm survival declined with an increasing rate of cassava pulp concentration. However, earthworms could survive 100% under

concentrations of 6.25 -18.75% of distillery slop, but using distillery slop at concentrations more than 18.75% led to lower survival rates. Cassava peel can absorb distillery slop more than cassava pulp which decreased the toxicity of distillery slop.

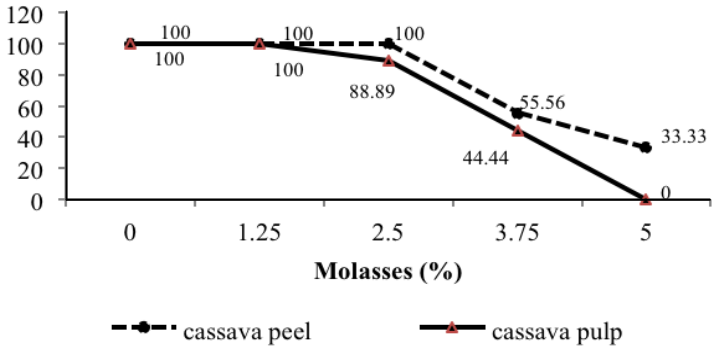

Fig. 3 The % survival of earthworms in the different concentrations of molasses mixed with cassava pulp and cassava peel

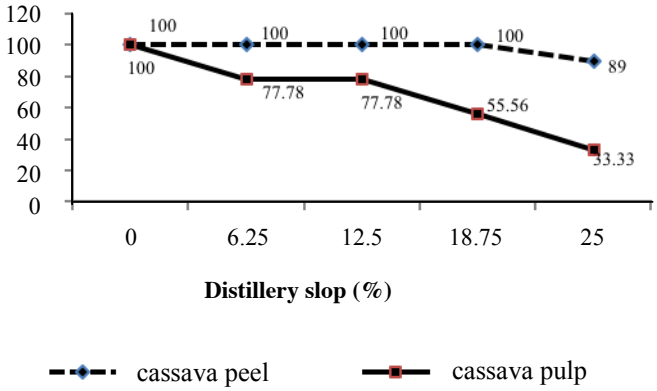

Fig. 4 The % survival of earthworms in the different concentrations of distillery slop mixed with cassava pulp and cassava peel.

CONCLUSION

The study of the survival of earthworms on organic materials (molasses and distillery slop) mixed with cassava industrial wastes found that the use of molasses mixed with cassava pulp or cassava peel at molasses concentrations lower than 2.5% resulted in an earthworm survival rate of 100%, but the use of molasses at concentrations more than 3.75% resulted in lower survival rates. On the other hand, cassava pulp mixed with distillery slop at 6.25-12.5% concentration levels of distillery slop promoted an earthworm survival rate of 77.78%. The use of distillery slop mixed with cassava peel, with distillery slop concentration levels of 6.25-18.75% promoted an earthworm survival rate of 100%. High concentrations of molasses and distillery slop have high electrical conductivity (EC), or salinity, which affects the survival of earthworms. Therefore the use of molasses and distillery slop should be kept at an optimum rate.

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REFERENCES

Cleasby, T.G. 1963. The feeding value of molasses. Proceedings of the South African Sugar Technologists' Association (http://www.sasta.co.za.)

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.

Pundee, K. 2006. Influence of molasses on composting of cassava. Master of Science. Department of Natural Resource Management, Faculty School of Bioresources and Technology, King Mongkut's University of Technology Thonburi. Thailand.

Sharma, P., Setia, R.K. and Dutta, S.K. 2007. Potential use of distillery effluent in agriculture, Indian Journal of Ecology, 34(1), 50-53.

Soongsud, P. 2008. Utilization of spent wash liquor from ethanol factory for the sugar cane production. Master of Science thesis in soil science, Graduate School, Khon Kaen University. Thailand.

Toncho, A. 2007. Earthworm. National science and technology development agency, Patumthani. 260.