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RESEARCH ARTICLE

Biodegradation of Domestic Organic Waste Using Earthworm (*Eudrilus eugenia):* A Veritable tool for Agricultural and Environmental Sustainability

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ABSTRACT

Biodegradation of organic waste using wild and cultured earthworm (*Eudrilus eugenia*) was compared in this study. Equal quantities of cultured and wild *Eudrilus eugenia (*0.4 kg) were used in vermicomposting of 4 kg organic waste for eight weeks. Result showed that biodegradation of organic waste using both wild and cultured earthworm was slower than the control but more environmentally friendly. There was no significant difference ($P>0.05$) between the rate of decomposition of organic waste by the wild and cultured earthworm and nutrient composition of the worm cast from the vermicompost unit, however there was significant difference ($P<0.05$) between worm cast from the two vermicompost units and that of untreated soil in favour of vermicomposting. Culturing of *Eudrilus eugenia* for vermicomposting and organic waste degradation is therefore recommended as a measure to tackle waste problems in Nigeria and to provide worms for livestock and fish farming.

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INTRODUCTION

The menace of solid waste and garbage emanating from socio-economic activities in the urban centre of Nigeria cannot be over-emphasized. An average per capita waste generation of 0.8 kg per person per day was reported by Achi (2000) while Afolabi (2002) reported waste generation of 0.45 kg/person/day (19.2 million tones) based on the findings of CASSAD (1997) and a projection of 28 million tones in 2010 when Nigerian population will be 151 million. Although materials such as paper, glass, ceramics, plastics, metals, leather, rubber, textile, animal and plants are usual components of the waste (Ogwuru, 1995), organic waste has remained the major component of the waste constituting 60-80 % (Afolabi, 2002). In classification of waste materials, Lardinois and Klundert (1993) identified organic waste to include agricultural waste, human and animal waste. As the global population continues to increase more organic wastes are bound to be produced, causing increase in environmental and agricultural challenges (Nwanta and Achi, 2002 and Mabogunye, 1996). These challenges are made worse in developing countries like Nigeria where waste management technique is crude and ineffective. Vermicomposting (a bioremediation technique of recovering organic nutrients through an efficient means devoid of pollution, producing organic fertilizer and fish feed) is a veritable tool for agriculture and environmental sustainability (Edward 1998, Guerro *et al.,* 1999 and Krogh, 2008). Vermicomposting is already a common practice in many developed countries (Guerro *et al*., 1999) where the earthworm species *Eisenia fetida* is used for production of organic fertilizer and fish feed. However, only little work has been done on the use of indigenous earthworm species *Eudrilus eugeniae* for vermicomposting and biodegradation purposes. This study is therefore aimed at investigating the biodegradation potentials of cultured earthworm (*Eudrilus eugeniae*) as compared to its wild counterpart as a waste management strategy for maintaining environmental health.

MATERIALS AND METHODS

Hand sorting technique as described by Glenn (2006) was used to collect earthworms from the open refuse dumpsite located at Umueze, outskirt of Enugu-ngwo, Enugu North Local government of Enugu State, South East, Nigeria with GPS coordinate of Latitude $000^0\ 25^1\ 32^{11}$N and Longitude $007^1\ 27^1\ 26^{11}$E.

Identification of earthworm

The earthworm was identified as *Eudrilus eugenia* using the method given by Ansari and Saywack (2010) and identification guide by Wormwatch.com. For authoritative identification, samples of the earthworm (adult, juvenile and cocoons) were taken to Professor C.C. Mba of the Department of Soil Science, Anambra State University Uli, Anambra State , Nigeria an expert in Soil Organism who identified the earthworm as *Eudrilus eugenia.*

Pre- composting of Domestic Organic waste

A collection of domestic waste comprising of vegetable stalks (spinach, pumpkin, garden egg, water leaf etc), tuber crop peels (yam, potatoes, cocoyam) and food scraps were sliced and mixed with 5 kg dried cow dung and saw dust in the ratio of 10: 5:3:1.5 and transferred into a transparent polyethylene bag to produce a total weight of 18.5 kg. Thereafter, the open end of the polyethylene was tied and kept in a concrete compost bin of 50 x 50 x 20 cm in accordance with Glenn (2006) method of pre-composting organic waste for vermiculture.

Vermiculture (Earthworm cultivation)

Vermiculture technique of [10] was also followed in culturing of the earthworms. It involved the use of shredded newspaper (2 x1 cm) to cover the bottom of the compost bin. Humus soil was then sprayed sparingly on top of the shredded newspaper, crushed egg shell, leached sandy soil, dried cow dung and decaying compost (from site where the worms were collected) and water were also added into the mix. The bedding was allowed to stand for three days. 4 kg of cooled pre-composted organic waste was introduced into the bin alongside with o.4 kg of juvenile *Eudrilus eugenia* in accordance with 1:10 ratio (Glenn, 2006). The vermiculture lasted for 8 weeks. It was done in three replicate units.

Vermicomposting

Nine compost bins were prepared as described for vermiculture above. Three out of the nine bins were used to replicate each of the experimental unit. The first experimental unit comprise of three bins labeled A_{1-3} containing 4 kg of wild *Eudrilus eugenia* used for vermicomposting of 0.4 kg pre-composted organic waste, that is, ratio of 1:10 in accordance with Glenn (2006), the ones labeled B_{1-3} contained equal quantity of pre-composted waste and cultured *Eudrilus eugenia* of similar size and weight to those collected from the wild, while bins C_{1-3} contained only pre composted waste without any earthworm and therefore served as the control. Each bin was calibrated from 0 to 10 cm from bottom to the top to determine the rate of decomposition of the compost. The experiment lasted for eight weeks.

Nutrient Content Analysis

The nutrient content of the leached sandy soil and the worm cast from the vermicomposting units were determined in the Chemistry Department of Project development Institute (PRODA) Enugu following the official methods of the Association of Official Analytical Chemistry (A.O.A.C., 2003). The nitrogen analysis was carried out using Nitrate and Ammoniacal Nitrogen Devarda method with methyl red as indicator. The cations were determined using atomic absorption spectrophotometer (AAS). In determination of the Phosphorus and Fixed Carbon content the calculation was P_2O_5 = Conc .x 250 x 0.05 x 100 x d.f.100 x weight of sample used
Fixed carbon (FC) = 100–(moisture+Ash+Volatile matter)

Statistical Analysis

Data obtained were analyzed using Statistical Analysis Software, 2002 version (SAS, 2002).

RESULTS AND DISCUSSION

The result of the findings on the potentials of cultured earthworm in bioremediation of organic waste is shown in Tables 1, 2 and 3. Table 1 showed the findings on sensory assessment of the changes in the organic waste during the eight week period of the experiment. Experimental units A_{1-3} which contained wild earthworms (*Eudrilus eugenia*) and B_{1-3} containing cultured *Eudrilus eugenia* respectively had gradual changes on the organic matter and without pungent odour or presence of maggots. The control C_{1-3} however had very fast degradation of organic matter, produced pungent odour and attracted flies, resulting in the presence of maggots. Table 2 further showed the rate of decomposition of organic matter in the three units; there was no significant ($P > 0.05$) difference in the rate of decomposition in A_{1-3} (Wild *Eudrilus eugenia*) and B_{1-3} units (Cultured *Eudrilus eugenia*). Decomposition was however very fast in the control C_{1-3} to the extent that on the fifth week decomposition has been completed in unit C_{1-3} and the bin was filled with maggots. The fast decomposition of the pre-composted organic waste in the control unit and the pungent odour are indications of presence of putrefying bacteria. Untreated and poorly managed compost are breeding grounds for disease vectors (Nwanta and Achi, 2002). Such unorganized and poor waste management has made Nigeria to be rated as the dirtiest, unsanitary and least aesthetically pleasing country in the world (Mabogunye, 1996). Vermicomposting whether with wild or cultivated earthworm is environmentally friendly as they did not produce odour or maggots.

Table 1: Sensory assessment of the experimental units

Parameters	Bins A_{1-3} (Wild earthworm)	Bins B_{1-3} (Cultured earthworm)	Bins C_{1-3} (Control)
Odour	Nil	Nil	Pungent
Presence/absence of maggots	Absent	Absent	Present

Table 2: Rate of Decomposition of Domestic Organic Waste (Average decomposition from the initial 10cm mark on the bins (cm))

Weeks	Bins A_{1-3} (Wild earthworm)	Bins B_{1-3} (Cultured earthworm)	Bins C_{1-3} (Control)
1	10	10	10
2	8.7	8.9	7.5
3	8.1	7.8	6.6
4	7.8	7. 7	6.0
5	7.4	7.5	5.4
6	7.3	7.2	5.4*
7	6.8	7.0	5.1*
8	6.5	6.6	5.1*

Maggots and remains of organic waste

Table 3: Mean Length (cm) of Randomly Selected earthworm in each of the Vermiccompost bin after 8 weeks of the study

	L1 (cm)	L2 (cm)	L3 (cm)	Mean	SEM
Bins A_{1-3} (Wild earthworm)	12.57	12.64	11.6	12.26	1.32
Bins B_{1-3} (Cultured earthworm)	14.80	13.40	14.62	14.27	1.75

Table 4: Comparison of nutrient composition of worm cast from sandy soil used for vermiculture and unused sandy soil

Nutrients	FC	N	P	Ca	K	Zn	Fe	pH
Unused Sandy soil	30.33	7.50	0.31	0.03	0.04	0.01	3.10	6.0
Wormcast	26.54	20.3	0.06	0.1	1.00	Nil	0.05	7

Table 3 showed the length of the *Eudrilus eugenia* showing the earthworms are sizeable enough to serve as fish feed. Table 4 showed the comparison between the nutrient composition of worm cast from vermicomposting (in A1-3 and B1-3) and that of unused sandy soil. The worm casts have a higher content of important nutrients Nitrogen, Calcium, potassium, though lower in phosphorus compared to the sandy soil. The increase in nutrient composition of the worm cast by over 60 % in essential plant nutrients (N, K and Ca) is an indication of its usefulness in agriculture. The neutral pH of the worm cast is in line with earlier study by Guerro *et al.*, (1999). According to Krogh (2005), worm cast and composts are considered to have positive effect on soil by helping to balance the pH, retain moisture, improve drainage and control pathogens.

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