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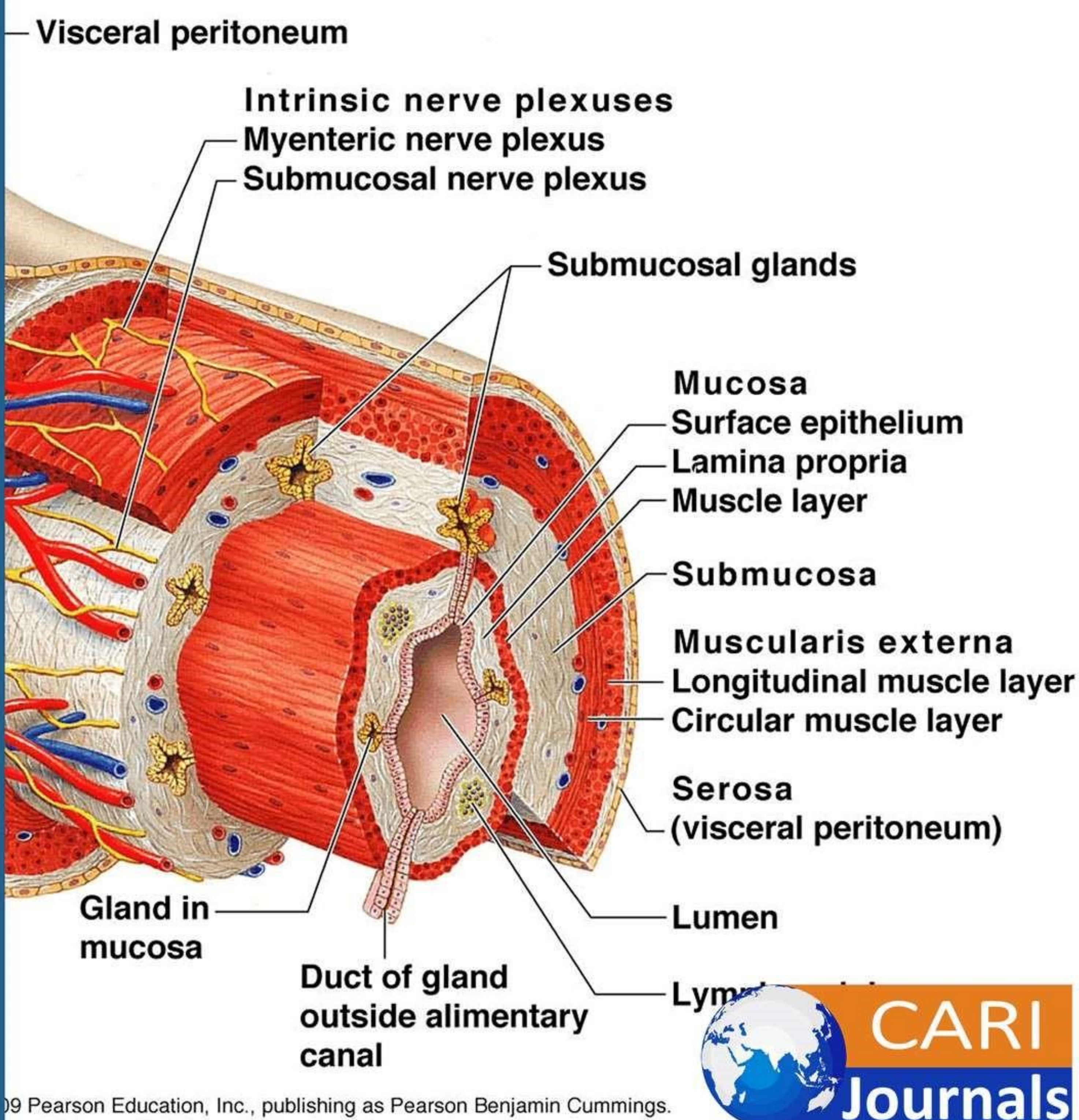

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NUTRIENT POTENTIAL FROM VERMICOMPOST OF TWO CONTRASTING ORGANIC WASTES USING TROPICAL EARTHWORM AND MOSQUITO NET AS CULTURE MATERIAL

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Abstract

The biochemical break down of plant litters by earthworm and the associated micro-organisms are the main process of humus development. Nutrient potential from vermicompost of two contrasting organic wastes using tropical earthworm (*Eudrilus eugeniae*) and mosquito net as culture material was studied. The organic wastes diet is fruit wastes (FRW) and vegetable wastes (VGW). Ten earthworms were inoculated to each of the eight (8) sacks. The result of the experiment after three (3) months and three (3) weeks inoculation showed that the *Eudrilus eugeniae* can be cultured in sack made from old window mosquito net and the vermicompost produced in each waste are of high-quality humus. The nutrient content of the vermicompost varied among the wastes. The pH level of the wastes was found to be alkaline of which VGW recorded higher value (9.15) compared to FRW. The OC content and electrical conductivity (EC) were significantly different among the treatments. Higher values of Na, OC, K, and P were recorded in FRW, while VGW recorded higher values in Ca, Mg and EC. The highest dry matter weight of 115.75gkg $^{-1}$ of vermicompost was recorded in VGW as against 109.5gkg^{-1} recorded in FRW. Earthworm production measured by the number survived, number of cocoons, and biomass weight at the end of the study showed VGW as best culture for earthworm production. FRW did not record any cocoon at harvest. Findings of the study confirm that tropical earthworm – *Eudrilus eugeniae* can be easily used for high quality vermicompost production which is socioeconomically very beneficial for soil fertility improvement and sustainable crop production. The wastes and the earthworm are in abundance in the study area and within the reach of the farmer. The farmers are therefore encouraged to harness this technology for their soil and crop production.

Keywords: *Organic wastes, Plant nutrient elements, compost, Vermicompost*

1.0 INTRODUCTION

Increase in urbanization resulting from rapidly increasing human population, industrialization, intensive crop production etc., to meet up food demand have led to monumental increase in solid waste production. The management of these wastes and its efficient disposal has become more rigorous and very problematic. As these wastes are sometimes disposed of indiscriminately, leading to blockage of drainage ways and other environmental hazards including heat problems. Some dump sites have equally taken some chunk of land that would have been put into crop production especially in this part of the country with very limited arable land for agriculture. Also, it constitutes an ugly site in the beauty of a state or town. In fact, poorly controlled open dumps and indiscriminate road side dumping and free flow of waste water in open gutters along streets, are common features in most Nigerian towns and cities. Nonetheless, wastes are inevitable consequences of human activities that are either a by-product of initial production processes or they arise when objects or materials are discarded after they have been used (Madu 2011). Hence its management with regard to maintaining healthy environment requires sustainable approach in a cost-effective manner (Wani et al, 2013). Furthermore Zirbes et al. (2011) pointed out in their work that wastes when piled up in large heaps creates a harmful greenhouse gas (CH_4) methane that damages earth atmosphere due to inability of the air to penetrate the organic waste that is degrading. It is equally a hide out for nocturnal animals that can transmit dangerous diseases to humans.

The good news is that there is a wonderful technology, that if employed by the government, cooperative organization, and indeed individuals, families will convert wastes into useful materials that will be very beneficial to our soil and environment. The technology is vermicomposting which involve the use of earthworm to convert solid organic wastes into vermicompost. Gosh (2004) reiterated that vermicomposting provides for the use of earthworms as natural bioreactors for cost effective and eco- friendly waste management. Earthworms are the most important soil organisms according to Kooch et al (2007) based on their influence on organic matter (OM), development of soil structural stability and nutrient cycling in productive ecosystem. Earthworm has the capacity to consume all kinds of organic diets of which include but not limited to crop wastes, Animal wastes, industrial wastes, vegetable wastes, abattoir waste, municipal wastes, poultry wastes, leaf litter wastes, sugar mill residues etc (Zambare et al., 2008; Nweke, 2013, 2016). Despite the vast increase in scientific literature on earthworms in recent years much still remains to be known of their feeding and casting ability with regard to different diets. Hence the objective of the study is to evaluate the nutrient potential from vermicompost of two contrasting wastes using *Eudrilus eugeniae.*

1.1 Materials and Methods Location of Experiment

The experiment was conducted at the Faculty of Agriculture of Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus. The experiment was carried out within the tropical rain forest of eastern Nigeria between the Latitude 06.14^1 and longitude $66^0 45^0$E.

1.2 Field Work

Fruit wastes (FRW) and vegetable wastes (VGW) were diets used to determine the survival rate of earthworm, vermicompost production and nutrient release composition These wastes were chopped and 4.5kg of each waste was put in a polythene bag and fermented for 3 weeks, after the 3 weeks fermentation 280g of each sample was mixed differently with 70g poultry manure that was moistened and the mixture was air dried for 24hours. Each treatment was placed in small sack made from old window mosquito net that was soaked in water for 24hours and washed properly before been used for the experiment. Each of the sacs was then placed inside a small basket of dimension 7cm x 17cm. The treatments were replicated 4 times. Ten (10) earthworms were collectively weighed and inoculated to each of the 8 sacks of two treatments. 0.75 litres of water was sprinkled on each sample every order day till harvest. There were deaths of earthworms after inoculation of which more was noticed in FRW than VGW but supplied was made which stopped two weeks after the commencement of the study. After 3 months and 3 weeks inoculation the worms were harvested by hand sorting and the worms were weighed collectively per sac. The resulting vermicompost made up of mostly earthworm casts were collected for oven dry matter content determination.

1.3 Laboratory Method

The resulting vermicompost was analyzed for the following parameters:

pH in water (H_20): This was determined by electrometric method the electrometric method is the most accurate of the methods employed for determination of hydrogen ion concentration and the accepted method for research and laboratory work necessitating pH measurement accurate to 0.1 to 0.001 pH.

Organic matter content: This was determined by the use of Walkley and Black acid digestion method of (1930).

Nitrogen content: This was determined by the use of modified Kjeidahl method.

Phosphorus: This was determined by the use of Bray II method.

Exchangeable base: This was determined by the use of ammonium acetate method

Electrical conductivity: It was determined using the ratio soil: water of 1:2.5 using a digital conductivity meter and a digital pH meter respectively

Statistical analysis: All data collected were subjected to T-test analysis and mean values were compared using the least significant difference (LSD) at 5% level of probability.

1.5 Results Examination of earthworm activities

The day to day examination of the earthworm culture showed that after one week of the inoculation the entire worm died in both treatments. Another batch of ten (10) was again inoculated on to the treatments after five (5) days degradation process was noticed in both treatments through cast production activities of the earthworms. However after two weeks of the inoculation deaths of earthworms were recorded in both treatments, four (4) in vegetable waste and five (5) in fruit waste, supply were made to complete the original ten (10) used in the treatments but that was the last supply made till the end of the study. Earthworm degradation of materials was active in both culture but not intensive. This invariable was reflected in the nutrient released composition of the vermicompost summarized in Table 2 and 3.

1.6 Nutrient content of wastes before vermicomposting

Table 1 shows that nutrient content of the wastes and poultry manure before earthworm inoculation. Vegetable waste had the highest values in parameters assessed which were pH in H_2O organic carbon, sodium, potassium, electrical conductivity of which the values were 8.7, 22.185%, 0.741cmolkg^{-1}, 1.275 cmolkg^{-1}, 195.00uscm^{-1} respectively which were different from the values of poultry manure and fruit waste. Poultry manure recorded the second highest value in those parameters but recorded the highest value of calcium and phosphorus (P) which was 5.60 cmolkg^{1} and 0.317 mgkg^{-1} respectively followed by vegetable waste which had 3.20 cmolkg^{-1} and 0.149 mgkg^{-1} respectively. Poultry manure also recorded the highest value in magnesium 1.92 cmolkg^{-1} followed by fruit waste 1.68 cmolkg^{-1} and then vegetable waste that recorded 0.96cmolkg^{-1}. Fruit waste recorded the list value in most of the parameters assessed.

Table 1 Nutrient content of the wastes before vermicomposting.

	Poultry manure	Fruit waste	Vegetable waste
PH H_2O	7.8	7.6	8.7
%C	18.075	0.918	22.185
Na^+ cmolkg^{-1}	0.624	0.297	0.741
K^+ cmolkg^{-1}	1.075	0.503	1.275
Ca^{2+} cmolkg^{-1}	5.60	1.20	3.20
Mg^{2+}cmolkg^{-1}	1.92	1.68	0.96
P mgkg^{-1}	0.317	0.093	0.149
EC µscm^{-1}	194.10	181.40	195.00

1.7 Nutrient release composition of vermicompost

Table 2 shows the nutrient release composition of two contrasting diets as influenced by earthworm. The treatments Fruit waste vermicompost (FRW) and Vegetable waste vermicompost (VGW) were significant ($P < 0.05$) at different parameters that were tested. These parameters were pH in H_2O, organic carbon and electrical conductivity. The value for FRW and VGW were 8.50 and 9.53 for pH in H_2O, 13.104% and 11.202% for organic carbon and 59.35µscm^{-1} and 136.70µscm^{-1} for electrical conductivity respectively the treatment however was not significant at parameters like sodium, potassium, calcium, magnesium and phosphorus. The value for FRW and VGW respectively were for sodium 0.437cmolkg^{-1} and 0.366cmolkg^{-1}, Potassium 0.753cmolkg^{-1} and 0.621cmolkg^{-1} calcium 2.50cmolkg^{-1} and 2.80cmolkg^{-1} magnesium 1.26cmolkg^{-1} and 1.62 cmolkg^{-1} and total phosphorus were 0.224mgkg^{-1} and 0.219mgkg^{-1}.

Table 2 Nutrient release composition of two contrasting diets as influenced by earthworm

Treatment	pH H_20	OC %	Na^+	K^+	Ca^{2+}	Mg^{2+}	TP	EC
			→	cmolkg^{-1}	←		mgkg^{-1}	µscm^{-1}
FRW	8.50	13.104	0.437	0.753	2.50	1.26	0.224	59.335
VGW	9.53	11.202	0.366	0.621	2.80	1.62	0.219	136.70
LSD	0.99	1.73	NS	NS	NS	NS	NS	18.48

FRW = Fruit waste vermicompost; VGW = Vegetable waste vermicompost

1.8 Vermicompost production/Earthworm biomass

The vermicompost dry matter weight value, earthworm weight, number of earthworm and cocoon are presented in Table 3. The dry matter weight of vermicompost shows that VGW has a higher weight than FRW with 115.75gkg^{-1} and 109.50gkg^{-1} respectively. Poultry manure enhanced vermicompost production with both wastes particularly with vegetable waste. Weight of earthworm at harvest indicated that VGW had a higher weight than FRW with $6.27gkg^{-1}$ and $3.75gkg^{-1}$ respectively, 6.15 and 5.50 respectively for recorded value of number of earthworms. FRW recorded 0 for number of cocoon and VGW recorded 2.5 indicating that VGW increased the earthworm weight, number and cocoon size. The result shows that the treatment FRW and VGW are not significantly different from each other at any level of parameters assessed.

Table 3 Vermicompost dry matter weight, earthworm weight, number of earthworms and cocoon.

Treatment	Dry matter weight of vermin compost gkg^{-1}	Weight of earthworm at harvest gkg^{-1}	Number of earthworms at harvest	Number of cocoon
FRW	109.50	3.75	5.50	0
VGW	115.75	6.27	6.15	2.5
LSD	NS	NS	NS	NS

FRW = Fruit waste vermicompost; VGW = Vegetable waste vermicompost

2.0 DISCUSSION

The result of this study is of evidence that earthworm can be cultured successfully using old window mosquito net and can produce vermicompost from the fruit and vegetable wastes. The initial deaths of worm recorded probably may be due to adaptability problems as the worms used for the experiment were sourced from ‘wild’ in their natural habitat. The nutrient content of the wastes before the vermicomposting (Table 1) showed that the materials used for the composting differed much in their nutrient composition. Some of the nutrients are at their lower levels while others are below critical levels. Hence, they influenced greatly the nutrient release ability of the resultant vermicompost (Table 2 and 3).

From the result obtained therefore there is evidence that nature of compost materials influenced the earthworms feeding activity resulting in an increase in release of plant chemical nutrients. There was increase in the release of chemical nutrients in the vermicomposts compared to the parent materials used for the production of the vermicomposts. This indicates conversion of nutrients in the wastes into plant-available forms during passage through the earthworm gut. The slight change in pH and decrease in the organic carbon (OC) content of the vermicompost compared to its parent materials could ascribed to mineralization processes of N, P and microbial decomposition of organic materials leading to the production of CO_2. It might as well be due to utilization of carbon by the worms as carbon and energy sources in growth and productivity. Elvira et al. (1998) recorded 1.2 – 1.7-fold loss of organic carbon as CO_2 in vermicomposting of paper mill and dairy sludge. The observed reduction in salinity of the wastes measured by electrical conductivity (EC) of FRW visa-vie its value in parent material might be attributed to production of ammonium and precipitation of dissolved salts during production process of vermicompost by the earthworms. The resultant vermicompost from the wastes consisted of high-quality humus with favorable pH level. Increase in earthworm weight, number survived and cocoon size observed in VGW relative to FRW could be attributed to increased nutrients in vermicompost and of nutrients thereof. The zero (0) recorded in FRW for number of cocoons may be associated with the duration of vermicomposting at which the cocoons were laid. From the result obtained VGW performed better than FRW treatment in nutrient release in this study.

3.1 CONCLUSION

The result of the study shows that the activities of the earthworm on organic waste such as fruit waste and vegetable waste enhance the nutrient composition and increased the weight of the earthworm. The increase in these parameters can help to promote soil fertility, microbial activities and environmental health. Earthworm are very vital in soil, if the ecology of earthworm will be taken into consideration the earthworm could effectively promote soil productivity and conservation sustainably. The nutrient release content is very high and also rich so it should be encouraged and the use of inorganic fertilizer should be discouraged as this kills the earthworm and render the soil infertile at a longer time.

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