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Production Of Vermicast Using Various Organic Waste Materials by African Night Crawler (Eudrilus eugeniae) Cultured on Portable Bin

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Abstract. Vermicomposting in portable bins is usually adopted nowadays after the public understanding of vermicompost process increased and its deployment to convert organic waste into vermicompost has been increasingly expanded. Using worms, the vermicomposting technique turns food scraps, manure, and other biodegradable waste into "vermicast," which is an excellent fertilizer. Ease of the vermicompost process and ability of its application in various scales made the vermicomposting a popular issue almost everywhere. The experimental descriptive research method was used in this study specifically the true experimental research design that relied on statistical analysis to approve or disprove a hypothesis. The researcher conducted a 15-day experiment to observe and collect data and the process were divided into two stages: development and assessment. A total of 12 portable bins were put up in the experimental study and used them in developing and accessing which organic substrates are highly efficient in producing vermicast. Four sets with triplicate (T) bins containing worms and soil for control, and for the experimental agricultural wastes for T1, food wastes for T2 and office waste for T3. These bins were observed for 15 days and from the data collected, researchers found out that in experimental bins, the replicates with agricultural wastes produced the highest amount of organic fertilizer or the vermicast, followed by the food waste (fruit peelings and vegetable scraps) and the least from office wastes (shredded paper). The findings in this study led to the statement that portable bins made from utility boxes can develop and produce organic fertilizer from Vermicomposting, using agricultural waste materials preferably.

Keywords: African nightcrawler; Eudrilus euneniae; Organic waste; Portable bin; Vermicast production

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1. Introduction

The problem on waste disposal management caused by modernization and expanded human population caused environmental problems such as global warming, lower production, and infertility of the soil can be healed through the continuous use of organic fertilizers such as compost, vermicast or any farm manures (Satchell, 2012). Vermiculture is one of the most promising technologies to answer the demand of people who used organic fertilizers.

Vermicomposting is a method of composting which uses worms to convert food scraps, manure, and other biodegradable waste into worm poop or vermicast, which makes for very good fertilizer. Vermicomposting needs both carbon and nitrogen-rich materials to be able to decompose. Carbon-rich materials such as used paper, leaves, etc. are used for the worms' bedding, while nitrogen-rich food scraps and green manure serve as worm food. It has also become popular and has recently been recognized as one of the most appropriate methods to stabilize organic waste. In terms of a system for waste management, vermicomposting is sustainable, economically viable, and without detrimental effects to human health or to the environment (Pirsaheb et al., 2013).

The idea of making one's own vermicomposting bin is not also new as more people are educated of its relevance to the environment; not only considering the value having organic fertilizer for home grown vegetables & plants, but more so on managing waste materials such as food scraps, garden waste into something useful with species earthworm like the African Nightcrawler. In Cuba, India and the Philippines, this worm is favoured most for producing vermicompost fertiliser for organic farming, whereas in North America and Australia the main commercial use is for breeding as fish bait (Blakemore, 2015).

Managing wastes properly is essential in achieving a clean, safe, sustainable and progressive place. Over the past year, the generated amounts of solid wastes including food wastes have been exponentially increased almost all over the world. This increase is attributed and correlated primarily with population growth. and to address problems, vermicomposting is one solution to the problem. According to Jara-Samaniego et al. (2017), improper waste management was found detrimental to the environment and human health. With the problems associated with the solid waste management, there is an urgent need to find ways and means to lessen its negative effect. Unless this is

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addressed, waste generation from various sources will continually lead to health hazards and environmental impacts such as ground and surface water contamination, flooding, air pollution and spread of disease. Vermicompost is beneficial for sustainable organic agriculture and maintaining balanced ecosystem (Kaur, 2020).

In this premise, the researchers developed a vermiculture bin that can function similarly as the existing small and large-scale composting models. Instead of using worm beds, the vermiculture bin was made out of plastic storage boxes then these was grouped into three substrates of different waste materials-agriculture waste, plant waste and food waste. The fourth group was the control group, with the worms and soil in the bin. The results helped in determining what substrate generated the most efficient vermicast in terms of volume and substrate left. The four groups of Vermiculture bins are prepared with the same quantity of worms and substrate materials, and it differs only in the waste materials used as worm beds.

2. Methodology

The experimental descriptive research method was used in this study specifically the true experimental research design that relied on statistical analysis to approve or disprove a hypothesis. According to Dawes (2010), the term true experiment is sometimes used to refer to any randomized experiment, hence, the term true experiment is used to describe all studies with at least one independent variable that is experimentally manipulated and with at least one dependent or outcome variable. The subjects of this study were the control bin and experimental bin. The researchers used the plastic utility boxes as the control and experimental bins, because of its availability, cost, size and portability. The control group with three (3) utility boxes as portable bins had 200 grams each of African Night Crawler (ANC) and same was done to the bins of the experimental group. The study was conducted from September to December 2021 at Aduas Norte, Cabanatuan City, Nueva Ecija, Philippines. This place was chosen for easy monitoring of the experiment.

3. Results and Discussion

3.1. Description of the Experimental and Control Bins

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The researchers prepared materials for vermicomposting and set up the Portable Vermiculture Bin (PVB) in four categories- 1 control and 3 experimental, to collect information needed in analyzing vermicast development and assessment. Agriculture, food and office wastes were used as substrate materials in experimental group while in the control, the researchers utilized soil. The design of utility boxes used as vermi or the ANC (E. eugeniae) culture bins were suitable as worm beds for the vermin composting both the utility boxes placed as worm beds in the experimental and control groups. Holes were appropriately put on the covers to allow airflow. However, despite the uniformity in weight and quantity of vermi placed in bins, they weighed differently after fifteen days while the control group with the vermi and soil showed an abrupt decrease in weight. Figure 1 shows the PVB and the substrate used in this study.

Figure 1 Portable Vermiculture Bin and different Substrate

3.2. Description of the experimental and control group after 15-day maintenance and maturation of vermicompost.

After 15 days of preservation and fruition of the experimental and control group, the amount of substrate, the amount of E*. eugeniae*, and vermicompost humus quality in worm beds were described as follows:

3.2.1. Amount of substrate left in worm beds

In the three different treatments, the weight of the substrate found in agricultural waste, kitchen waste, and office waste was weighed after 15 days. The actual quantity of the three substrate is presented in the table 1.

Table 1 Weight of the Substrate from Day 1 to 15

Treatment	Replicate	Weight of Substrate (kg)	
		Day 1	Day 15
	R1	1	0.75

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Treatment 1	R2	1	0.85
(Agricultural Waste)	R3	1	0.85
Treatment 2 (Kitchen Waste)	R1	1	0.75
	R2	1	0.80
	R3	1	0.80
Treatment 3 (Office Waste)	R1	1	0.90
	R2	1	0.95
	R3	1	0.95
Control	R1	1	1
	R2	1	1
	R3	1	1

The table demonstrates that, after Day 15, it is clearly shown that the weight of the substrate found in the three treatments after Day 15 has resulted to a lesser weight as compared to day 1 while it remains the same in the control bin. This result was confirmed to have significant difference per treatment made through the analysis of variance shown in Table 2. The result reveals that the F statistic of 11.17 exceeds the F-crit of 5.14 which has been the basis to reject the null hypothesis interpreted as the weight of the substrate from in three different categories of waste materials are significantly produced differently.

Table 2 Analysis of Variance for the Weight of the Substrate

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.037222	2	0.018611	11.16667	0.009496	5.143253
Within Groups	0.01	6	0.001667			
Total	0.047222	8				

3.2.2. Amount of E*. eugeniae* in worm beds

After 15 days, the weight of the vermi discovered in the three substrates for the three different treatments was measured. Table 3 displays the actual weight of the vermi collected from the three treatments after 15 days.

Table 3 Weight of the harvested vermi after 15 days

Treatment	Replicate	Weight of Substrate (kg)	
		Day 1	Day 15
Treatment 1 (Agricultural Waste)	R1	200	200
	R2	200	200
	R3	200	200
Treatment 2 (Kitchen Waste)	R1	200	200
	R2	200	200

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	R3	200	200
Treatment 3 (Office Waste)	R1	200	150
	R2	200	150
	R3	200	150
Control	R1	200	75
	R2	200	50
	R3	200	50

The table shows that the amount of vermi collected in kitchen and agricultural waste remained unchanged, but it decreased to 50 g in office waste. This indicates that even after 15 days, all of the day-planted vermi in the kitchen and agricultural trash in three duplicates survived. After 15 days in the office garbage, 50 g, or 25% of the worms, have already perished. With no treatment, it had significantly worse effects in the control group, killing more than 75% of them.

3.2.3. Humus Quality of Vermicompost

Color, odor and texture was observed after 15 days to check the quality of humus. According to Guerrero (2010), good humus has rich brown or dark brown color and crumbly to the touch. It will be dry and crumble between fingers like coarse sand. Table 4 describes the quality of humus in terms of physical properties.

Table 3 Humus Quality After 15 Days in Terms of Physical Properties

Treatment	Color	Odor	Texture
Treatment 1 (Agricultural Waste)	Dark brown	Earthy smell, no bad odor or pungent odor	Slightly moist, crumbly
Treatment 2 (Kitchen Waste)	Dark brown	Odorless	Moist, mud-like
Treatment 3 (Office Waste)	Brown	Odorless	Moderately clumpy, mud-like

According to Table 3, Treatments 1 and 2 have a dark brown color, while Treatment 4, which is lighter in color than Treatments 1 and 2, has a browner hue. Treatments 2 and 3 are both odorless, while Treatment 1 lacks any unfavorable odor. While Treatments 2 and 3 have a mud-like texture that is damp and little clumpy, Treatment 1 is slightly moist and crumbles. After 15 days of treatment, the following treatments entails that the worms in different treatments are considered healthy even though the ANC worms have varying physical characteristics.

3.3. *Differences between substrate materials in three treatments in the Vermicast Production*

After 15 days of experiment, the differences in the results in terms of weight of substrates, vermi and vermicast production was described.

3.3.1. Weight of Substrate

The researchers observed 4 duplicated sets of substrate materials with various treatments in the experimental group and 1 replicated set in the control group to ascertain the development of vermicast after fifteen (15) days. Table 5 shows the difference of substrate weight after day 15.

Table 5 Differences in the Weight of Substrate

Treatment	Replicate	Weight of Substrate (kg) Day 1	Day 15	Decrease in Weight of Substrate	Average weight at Day15
Treatment 1 (Agricultural Waste)	R1	1.000	0.750	0.25	0.8167 kg
	R2	1.000	0.850	0.15	
	R3	1.000	0.850	0.15	
Treatment 2 (Kitchen Waste)	R1	1.000	0.750	0.25	0.7833 kg
	R2	1.000	0.800	0.20	
	R3	1.000	0.800	0.20	
Treatment 3 (Office Waste)	R1	1.000	0.900	0.10	0.9330 kg
	R2	1.000	0.950	0.05	
	R3	1.000	0.950	0.05	
Control	R1	1.000	1.000	0	1.000 kg
	R2	1.000	1.000	0	
	R3	1.000	1.000	0	

As shown in the table, the duplicated sets of the vermi bins with the Control group—which consisted of soil and vermi—retained their initial weight of 1 kilogram after 15 days. The three replicated sets of substrate materials with various treatments, on the other hand, had varying weights.

3.3.2. Weight of Vermi

The differences in the weight of vermi after 15 days of experiment was shown in table 6.

Table 6 Differences in the Weight of Vermi

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Experimental Bin	Replicate	Weight of Substrate (kg)		
		Day 1	Day 15	Differences
Treatment 1 (Agricultural Waste)	R1	200	200	0
	R2	200	200	
	R3	200	200	
Treatment 2 (Kitchen Waste)	R1	200	200	0
	R2	200	200	
	R3	200	200	
Treatment 3 (Office Waste)	R1	200	150	50
	R2	200	150	
	R3	200	150	
Control	R1	200	75	25
	R2	200	50	50
	R3	200	50	50

The table demonstrates that the experimental bins with three treatments had the same weight from Day 1 to Day 15, indicating that treatments 1 and 2, which contained agricultural and food wastes, respectively, had a 100% survival rate. When the population of earthworms, the production of vermicompost, and the chemical and microbial characteristics of the vermicompost were recorded after fifteen (15) days, the results showed that there were significant differences in the different treatments in the control and treatment 3 bins. This indicated that agricultural waste and food wastes had more appropriate substrate materials for the vermicomposting.

3.3.3. Weight of Vermicast Production

The researchers were able to collect vermicast from the experimental bins for a period of fifteen (15) days. When they weighed the vermicast from the three treatments, they discovered the following results. Table 7 shows the differences of the yielded vermicast in three different treatments.

Table 7 Differences in the Weight of the Yielded Vermicast

Experimental	Replicate	Weight of Vermicast (g)	Average weight of vermicast harvested DAY 15
Treatment 1 (Agricultural Waste)	R1	350	303.33 grams
	R2	300	
	R3	260	
Treatment 2 (Kitchen Waste)	R1	250	225 grams
	R2	225	
	R3	200	
	R1	150	

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Treatment 3 (Office Waste)	R2	100	133.33grams
	R3	150	
Control	R1	0	0
	R2	0	
	R3	0	

In a span of fifteen (15) days, the researcher was able to harvest vermicast in the experimental bins and as she weighed the vermicast from the 3 treatments, the following findings were obtained: Treatment 1 or the agricultural wastes harvested an average of 303. 33 grams of vermicast, followed by treatment 2 (fruits and vegetables scraps) with 225 grams and lastly, the office waste with 133.33 grams of vermicast in 15 days. From the findings, it can be drawn that agricultural wastes consist of cow manure, rice straw and banana thrashes as substrate content produced the highest amount of vermicast from the 3 replicates, followed by food waste, comprised of fruit peelings, vegetable scraps and cow manure with an average of 225 grams, also from the 3 replicates. The least amount of 133.33 grams from the 3 replicates of office waste had been collected, all in Day 15. It also implied that after 15 days, all the bins with 3 treatments had differences in the amount or weight of vermicast produced.

3.4. Findings in Experimental and Control Groups of Vermicast Production

The results from the experimental and control bins demonstrate that the following null hypotheses are not true: After 15 days, there is a substantial difference between the control and experimental groups in terms of substrate material and vermicast production as shown in table 8.

Table 8 Differences in the Results of Experimental and Control Groups

Treatment	Replicate	Weight of Substrate		Decrease in Weight of Substrate	Average weight at Day 15
		Day 1 (kg)	Day 15(kg)		
Treatment 1 (Agricultural Waste)	R1	1	0.75	0.25	0.8167 kg
	R2	1	0.85	0.15	
	R3	1	0.85	0.15	
Treatment 2 (Fruit &	R1	1	0.75	0.25	0.7833 kg
	R2	1	0.8	0.2	

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Vegetable Scraps)	R3	1	0.8	0.2	
Treatment 3	R1	1	0.9	0.1	
(Office Waste)	R2	1	0.95	0.05	0.933 kg
	R3	1	0.95	0.05	
	R1	1	1	0	
Control	R2	1	1	0	1.000 kg
	R3	1	1	0	

According to the data gathered, the replicates with agricultural wastes produced the most organic fertilizer, or vermicast, in the experimental bins, followed by the replicates with food waste and the least from office wastes. From Day 1 to Day 15, there were variations in the outcomes of substrate materials, vermi, and vermicast harvested in control and experimental bins.

4. Conclusions

The vermi worms that are stocked on soil alone were not able to produce vermicast in control bin with soil as substrate, while vermicomposting in portable bins using three treatments- agricultural waste, fruits & vegetable scraps and office waste was successful in developing and producing vermicast from equally distributed substrate. However, the amount of vermicast were at different quantities due to earthworm's activity in the vermi beds treated with different waste materials. There is a significant difference between the substrate material and the vermicast produced in the portable bins. The substrate materials treated with agricultural waste were more productive in terms of vermicast harvested than fruit and vegetable waste and office waste. Further, there is a significant difference between the experimental group and the control group after 15 days. The control bin with vermi and soil was not ideal for vermicast production, because most of the vermi worms were dead after 15 days, and this makes no yield of vermicast. Moreover, there is a significant difference between the weights of the substrate, vermicast produced, and the population of vermi left in the bins in the control group and three different categories of experimental group after 15 days.

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