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# Wastepaper as substrates for African night Crawler (*Eudrilus eugeniae* Kinberg)

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## ABSTRACT

The study assessed the different wastepaper as substrates for *Eudrilus eugeniae*. The study was carried out at the Center for Environmental Resources Management and Sustainable Development (CERMSD), College of Forestry, Environment and Resources Management (CFERM), Nueva Vizcaya State University (NVSU), Bayombong, Nueva Vizcaya. A Complete Randomized Design (CRD) was used with six treatments and four replications. A study used different wastepaper such as bond, notebook, carton, newsprint mixed with goat manure in 1:2 ratio. Results revealed that different wastepaper like bond paper, notebook, carton, newsprint can be successfully used as substrate for African night crawler. However, the different wastepaper had a substantial effect on the weight of vermicompost produced and the percent recovery, newsprint and goat manure in 2:1 ratio gave significantly highest weight of the vermicompost produced and highest percent recovery. Hence, this substrate is recommended for vermicomposting using goat manure. Laboratory analysis of vermicompost as to its NPK content, nitrogen gave 0. 87% to 1.05%, for phosphorus amounted to 0.57135% to 1.06027%, and potassium measured 0.001471% to 0.001639%. From the result the NPK content of the different treatments is low. Regardless of the amount of nutrients contained in these substrates, these can help in enhancing soil fertility and is vital for plant growth and development. At the same time, through this process, the paper waste problem can be addressed while producing vermicompost that can be used as an organic fertilizer.

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## INTRODUCTION

Wastepaper is the second most produced solid waste in the Philippines, contributing nineteen percent of the total municipal solid waste production (Parayno, 2004). Perhaps, it is because of the shift from plastics to paper substances. Paper waste can be used in different sectors, such as markets, schools, offices, restaurants, and other establishments. According to the Philippine Development Bank, almost 61 percent of the total paper consumption is from the local pulp and paper industry (Tenorio *et al.*, 2001 as cited by Parayno *et al.*, 2004). The yearly per capita paper usage in the Philippines is 13 kg which significantly lower than that of wealthy nations (DBP, 2005 as cited by Parayno *et al.*, 2004). The same study revealed that Metro Manila and other metropolitan regions in the Philippines exhibit the highest density of paper usage. Paper waste problems are primarily attributed to the lack of segregation, facilities, and equipment to convert paper into beneficial components. The majority of the collected paper in the country goes to landfills, and some is recycled.

Hence, with the aid of science and research, we could address the problem of paper waste management through the process of vermiculture. This is one of the promising technologies for converting paper waste into organic fertilizers (Espina *et al.*, 2022). Vermicomposting is the use of earthworms to convert papers into worm poop or vermicast which is good for fertilizer. The efficient vermicomposting species is the *E. eugeniae,* which will be able to consume different paper waste through the process of vermicomposting, which requires carbon and nitrogen-rich materials. Furthermore, Tababa (2023) states that African night crawlers have voracious appetites for organic matter. They consume a wide range of materials, including kitchen scraps, garden waste, and manure. Their continuous feeding helps break down organic material more rapidly which is why determining the suitable substrate for African night crawlers is important.

This study addresses that gap by investigating the impact of various paper waste substrates- bond paper, notebook paper, carton, newsprint, and paper bags - on the growth, reproduction, and vermicast output of *Eudrilus eugeniae*. Lastly, the study wants to determine the most suitable substate for African night crawler. The findings could contribute significantly to wastepaper management strategies and promote sustainable agriculture through organic fertilizer production.

## MATERIAL AND METHODS

The study was conducted at the Center for Environmental Resources Management and Sustainable Development (CERMSD) at Nueva Vizcaya State University. In this study, a two-kilogram African nightcrawler was bought at CERMSD. The different wastepaper and manure were collected outside and inside the university campus and were prepared before buying the African night crawler. Sacks of rice were utilized in the experiment and placed beneath the 1 m × 5 m concrete vermicomposting bed. Mature and young African night crawlers were counted and weighed on the termination day of the vermicomposting set-up to determine the differences from the start of the study. The number of eggs of the African night crawlers was also counted. The vermicompost was analyzed at the Soil Laboratory of the College of Agriculture (CA), Nueva Vizcaya State University, Bayombong, Nueva vizcaya.

### Preparation of the substrates

The different substrates used in the study such as used/recycled notebook, used bond paper, clean bond paper, newsprint and carton, were obtained and shredded at the Center for Environmental Resources Management and Sustainable Development (CERMSD), of the College of Forestry and Environmental Resources Management (CFERM) at the Nueva Vizcaya State University Bayombong, Nueva Vizcaya. Various wastepaper was shredded using a shredder and goat manure was sundried and pulverized before using. Six kilograms of paper wastes were combined with twelve (12) kilograms of goat manure. Tap water was added to the mixed goat manure and

wastepaper to maintain its moisture. The following are the treatment descriptions:

T1 - 1 kg bond paper and 2 kg swine manure (Control)
T2 - 1 kg used bond paper and 2 kgs goat manure
T3 - 1 kg used notebooks and 2 kgs goat manure
T4 - 1 kg cartons and 2 kgs goat manure
T5 - 1 kg newspaper and 2 kgs goat manure
T6 - ½ kg cartons, ½ kg bond paper, and 2 kgs goat manure

The Complete Randomized Design (CRD) was used in this experiment. There were six treatments, each of which was replicated four times. The collected data were analyzed using the Statistical Tool for Agricultural Research (STAR), developed by the International Rice Research Institute's (IRRI). This tool is intended for the Analysis of Variance under a Completely Randomized Design.

## RESULTS AND DISCUSSION

This study examined the effect of different wastepaper mixed with goat manure in 1:2 ratio as feeding materials for African night crawler. Results showed statistically significant differences in the weight of vermicompost produced by African night crawler and percent recovery which expressed the ratio of the amount of the vermicompost produced over the amount of substrates fed in the worms. Other parameters did not yield significant differences when fed with different wastepaper.

### Weight of the vermicompost

Statistical analysis on the weight of vermicompost produced by African night crawler resulted in significant differences among the different substrates fed. Fig. 1 shows the results in weight of vermicompost produced by the *E. eugeniae*. The weight of vermicompost ranged from 84.00 g to 1512.00 g. Among all treatments, T5 (newspaper + goat manure) produced the highest vermicompost amounting to 1512.50 g, followed by T6 (mixed paper + goat manure, 1430.00 g). In contrast, T2 (used bond paper + goat manure) resulted in the lowest yield (84.00 g). The ease of decomposition and palatability of newspaper fibers, due to their thin structure and minimal chemical treatment, likely explains the higher vermicompost yield in T5. This is in contrary with the findings of Castañeto and Castañeto (2005), who reported increased vermicompost output when using paper substrates like carton and bond paper.

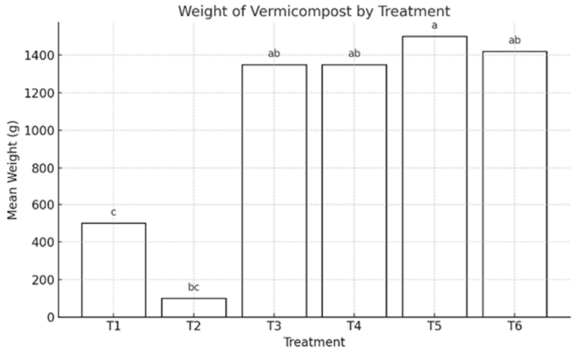


**Fig. 1.** Weight of vermicompost

### Weight of unconsumed substrates

Statistical analysis of the data on the weight of the unconsumed substrates fed to African night crawler revealed insignificant results. The remaining substrates fed to African night crawler did not differ significantly in different substrates formulations. The weight of unconsumed substrates ranged from 1300.00 g to 2052.00 g as shown in Fig. 2.

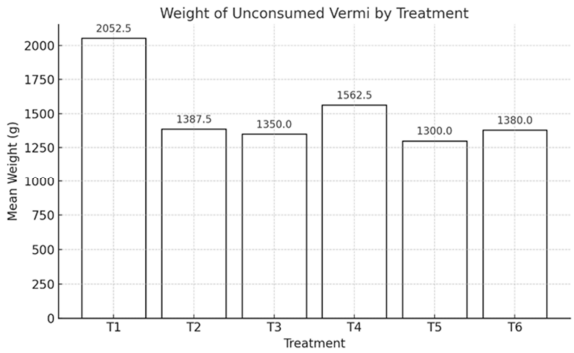


**Fig. 2.** Weight of unconsumed substrates

As shown in the above Fig. 1, T1 (clean bond paper + swine manure) yielded the highest unconsumed substrate of about 2052.50 g), suggesting poor substrate consumption. In contrast, T5 had the lowest residual material (1300.00 g). This indicates that newspaper is more digestible and preferred by

African night crawler. Aira *et al.* (2006) emphasized the role of fungi in enhancing palatability, which may have been more active in T5.

**Number of adult African night crawler (ANC)**

Accordingly, the number of adult African night crawler was not affected by the different substrates fed to them. Results of the statistical analysis revealed no significant effect. Fig. 3 showed the result on the number of adult African night crawler. The number of adult African night crawler ranged from 22.00 to 52.59. The T6 recorded the highest number of adult ANC (52.50) followed by T1 (45.00), a second highest number of African night crawler. Those ANC fed with cartons (T4) had the lowest number (22.00) of adult ANC. Kabi *et al.* (2020) found that substrate nutrient quality significantly affects both worm mass and reproduction.

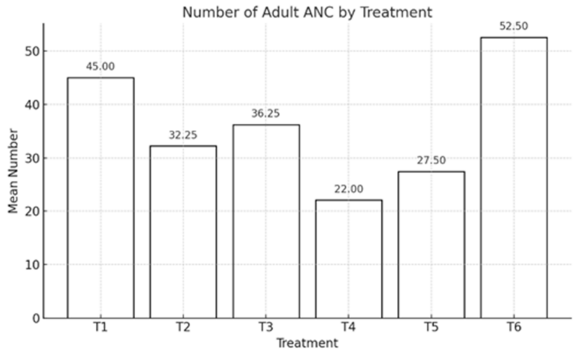


**Fig. 3.** Number of adult ANC

**Weight of adult African night crawler (ANC)**

Same was observed on the weight of adult African night crawler. Statistically no significant differences were noticed as a result of the different substrates fed to the ANC. Fig. 4 shows the weight of adult African night crawlers. The weight of ANC ranged from 8.00 g to 54.25 g. Treatment 1, which is the combination of swine and clean bond paper, has the highest number of adult ANC, the reason why it has a higher weight of ANC, with a mean of 54.25 among the different substrates. Treatment 5, which is the combination of newspaper and goat manure with the ratio (1:2) has the lowest weight of adult ANC with the mean of 8.00. It was noted that the weight of ANC varies depending on its size. This was supported by Kabi *et al.* (2020) which states that depending on the substrates the growth of the earthworms may vary.

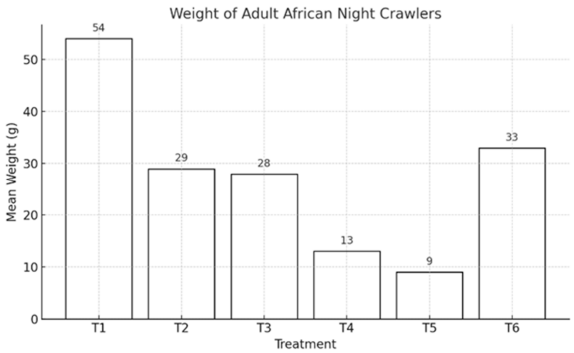


**Fig. 4.** Weight of adult African night crawlers

**Number of juveniles and eggs of African night crawler**

Table 1 shows the number of juveniles and eggs of the African night crawler. Statistical analyses of the number of juveniles and eggs did not show significant differences when fed with the different substrates. There were very few juveniles counted from 1.00 to 20.50. Juvenile counts were highest in T1 (20.50), followed by T2 (10.75), with T4 yielding the least (1.0).

**Table 1.** Number of juveniles and eggs

| Treatment | Number of juveniles | Number of eggs |
|---|---|---|
| T1 - clean bond paper and swine manure (1:2) | 20.50 | 1.75 |
| T2 - used bond paper and goat manure (1:2) | 10.75 | 3.75 |
| T3 - used notebook and goat manure (1:2) | 7.00 | 1.75 |
| T4 - carton and goat manure (1:2) | 1.00 | 0.00 |
| T5 - newsprint and goat manure (1:2) | 2.25 | 0.00 |
| T6 - carton and used bond paper and goat manure (1:2) | 4.25 | 0.00 |

On the other hand, egg counts were observed in T2 (3.75), suggesting it promoted early reproductive output. Treatments 4, 5, and 6 did not produce any eggs. These findings support the idea that certain substrate combinations may stimulate worm maturity (T1) while others stimulate early reproduction (T2), consistent with Pramanik *et al.* (2010), who linked microbial activity and nutrient content to reproductive efficiency.

**Percent recovery**

In vermicomposting the percent recovery is very important. This is the ratio of the amount of vermicompost produced over the amount of substrates fed to the African night crawler.

Statistical analysis of the percent recovery showed significant differences in percent recovery because of the different substrates given to ANC.

**Table 2.** Percent recovery

| Treatment | Mean |
|---|---|
| T1 - clean bond paper and swine manure (1:2) | 24.31$^{c}$ |
| T2 - used bond paper and goat manure (1:2) | 42.00$^{bc}$ |
| T3 - used notebook and goat manure (1:2) | 65.62$^{ab}$ |
| T4 - carton and goat manure (1:2) | 64.75$^{ab}$ |
| T5 - newsprint and goat manure (1:2) | 75.62$^{a}$ |
| T6 - carton and used bond paper and goat manure (1:2) | 71.50$^{ab}$ |

Table 2 shows the percent recovery of African night crawlers which ranged from 24.31% to 75.62%. The percent recovery was highest in T5 (75.62%) and the said treatment is significantly different to other treatments. Treatment 5 was followed by T6 (71.5%) which is not significantly different from T4 (64.75%) and T3 (65.62%). Treatment 1 recorded the lowest (24.31%). High recovery values indicate better decomposition and conversion efficiency, which is critical in vermicomposting operations. Edwards and Arancon (2004) noted that substrates with ideal carbon-to-nitrogen (C: N) ratios result in higher conversion efficiencies.

**NPK composition of vermicompost**

The vermicompost produced in different treatments were subjected to laboratory analysis. Among the different macronutrients, analyses were done only for nitrogen, phosphorus and potassium. For nitrogen, the total N ranged from 0.87% to 1.05%. Treatments 1 and 3 had the lowest nitrogen content (0.87%) while the rest of the treatments (2,4,5, and 6) had higher nitrogen content (1.05%) (Table 3).

**Table 3.** NPK composition of vermicompost

| Kind of sample | Macronutrient | | |
|---|---|---|---|
| | Total N (%) | Available Phosphorus (%) | Exchangeable Potassium (%) |
| T1 Bond paper and swine manure (1:2) | 0.87 | 1.06027 | 0.001590 |
| T2 Used bond paper and goat manure (1:2) | 1.05 | 0.57135 | 0.001536 |
| T3 Notebooks and goat manure (1:2) | 0.87 | 0.75570 | 0.001471 |
| T4 Cartons and goat manure (1:2) | 1.05 | 0.58795 | 0.001501 |
| T5 Newspaper and goat manure (1:2) | 1.05 | 0.57822 | 0.001559 |
| T6 Mixed cartons and used bond paper and goat manure (1:2) | 1.05 | 0.63547 | 0.001639 |

On available phosphorus, results of the laboratory analysis gave 0.57135% to 1.06027% for the different treatments in the study. Treatment 1 gave the highest phosphorus content (1.06027%) over the rest of the treatments. This is followed by T3 (0.7557%), and the rest have a relatively lower amount of phosphorus. Accordingly, phosphorus is helpful for plant health and stress resistance.

For the exchangeable potassium analyses of different treatments, yielded low amount of potassium from 0.001471 to 0.001639. Among the different treatments, T6 showed a little higher percentage of potassium over the rest of the treatments, followed by T1 and T5. The differences in nutrient profiles reflect variations in substrate chemical composition and microbial breakdown. Atiyeh *et al.* (2000) and Bernal (2009) highlighted that vermicast nutrient quality depends heavily on the substrate's organic content and microbial activity. In addition, regardless of the amounts of nutrients, it can be concluded that the different substrates used in this study can produce a fertilizer through the aid of the African night crawler. Through this study, we can address the problem of paper waste at the same time producing vermicompost that can be used as an organic fertilizer, which is essential for plant growth and development.

**Table 4.** Summary results of different parameters

| Treatment | Weight of vermicompost | Weight of unconsumed vermicompost | Number of adult African night crawlers | Weight of an Adult African night crawler | # of Juveniles | # Eggs | % Recovery |
|---|---|---|---|---|---|---|---|
| 1 | 486.25$^{c}$ | 2052.50 | 45.00 | 54.25 | 20.50 | 1.75 | 24.31$^{c}$ |
| 2 | 84.00$^{bc}$ | 1387.50 | 32.25 | 30.00 | 10.75 | 3.75 | 42.00$^{bc}$ |
| 3 | 1312.50$^{ab}$ | 1350.00 | 36.25 | 29.00 | 7.00 | 1.75 | 65.62$^{ab}$ |
| 4 | 1295.00$^{ab}$ | 1562.50 | 22.00 | 13.00 | 1.00 | 0.00 | 64.75$^{ab}$ |
| 5 | 1512.50$^{a}$ | 1300.00 | 27.50 | 8.00 | 2.25 | 0.00 | 75.62$^{a}$ |
| 6 | 1430.00$^{ab}$ | 1380.00 | 52.50 | 34.50 | 4.25 | 0.00 | 71.50$^{ab}$ |

**Summary of the analysis of the different parameters**

Table 4 shows the summary of the results of analysis of the different parameters. From the above table, out of the seven parameters tested, weight of vermicompost and percent recovery were significantly affected by the different types of substrates fed to the African night crawler.

Treatment 5, which is a combination of newsprint and goat manure (1:2 ratio) yielded the highest vermicompost (1512.5 g) and percent recovery (75.62%), and significantly different from the different treatments. This shows efficient substrate decomposition. In contrast, Treatment 1 (bond paper and swine manure (1:2 ratio) had the lowest recovery (24.31%) despite producing the heaviest adult worms and the highest number of juveniles, suggesting poor substrate conversion.

The different wastepaper fed into the African night crawler did not affect the weight of unconsumed substrates, number (eggs, young and adult) and weight of African night crawler.

These findings align with previous studies emphasizing the importance of substrate quality, particularly nutrient balance and C:N ratio, in enhancing vermicomposting efficiency (Edwards and Arancon, 2004; Gunadi and Edwards, 2003; Suthar, 2009).

Finally, the study shows that significant differences were observed in the weight of vermicompost produced and the percent recovery when African night crawler given different waste papers mixed with goat manure. The newsprint and goat manure in 1:2 ratio in higher weight of vermicompost and percent recovery. These two parameters are very important in vermicomposting. Hence, these findings echo those of Suthar (2008), who noted that substrates like paper waste are viable substrates or feeding materials for African night crawler because of their cellulose content, provided they are adequately supplemented with nitrogen sources like manure. Rose *et al.* (2022) further supported that substrate formulation directly influences the speed and efficiency of vermicompost production.

## CONCLUSION

After 28 days of observation, the different wastepaper (bond, notebook, carton and newsprint) mixed with goat manure can be a feasible substrate for African night crawler in vermicomposting. Statistical analysis revealed that the different wastepaper used in the study significantly affected the weight of vermicompost produced and the percent recovery. Among the different wastepaper used, Treatment 5 (newsprint and goat manure in 1:2 ratio) has the highest weight of vermicompost and percent recovery.

## RECOMMENDATION(S)

Based on the findings it is suggested that newspaper and goat manure in 1:2 ratio can be used as substrate for African night crawler to improve the weight of vermicompost and the percent recovery during vermicomposting. The same research may be conducted to verify results before giving the results to farmers and other stakeholders. Second, expand laboratory analysis of other nutrients contained in the vermicompost.

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