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Research Article

Paper Waste as A Substrates for African Night Crawler (*Eudrilus eugeniae*)

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ABSTRACT

The increasing generation of paper waste presents significant environmental challenges. Vermicomposting offers a sustainable means of recycling biodegradable materials through earthworm activity. This study evaluated the growth, reproduction and vermicompost yield of the African Night Crawler (*Eudrilus eugeniae*) cultured on various paper waste substrates combined with manure. A Completely Randomized Design with six treatments and four replications was used: swine manure (control) and cow manure mixed with clean bond, used bond, notebook, carton, and newspaper wastes.

Data on *Eudrilus eugeniae* proliferation, egg production, biomass, vermicompost yield, unconsumed substrate, and percent recovery were analyzed using ANOVA and Tukey's HSD test at 5% significance ($p < 0.05$). Results showed that combining cow manure with paper wastes significantly improved *E. eugeniae* performance compared to the swine manure control(T1). *E. eugeniae* number increased from 112.25 (T1) to 808 (T5), egg production from 8.25 (T1) to 486 (T4), and vermicompost yield from 375 g (T1) to 1925 g (T4). Percent recovery peaked at 96.25% in T4, while unconsumed substrate was lowest (187.5 g). The carton and

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cow manure and newspaper and cow manure combinations yielded the best results, confirming their suitability as effective substrates for vermicomposting.

The study concludes that cow manure-based mixtures, particularly with carton or used bond paper, provide optimal conditions for *E. eugeniae* and produce high-quality vermicompost. These findings highlight vermicomposting as a dual strategy for waste reduction and soil fertility improvement.

Keywords: *Vermicomposting, African Night Crawler (Eudrilus eugeniae), Paper waste substrate, Cow manure*

Background

Paper waste contributes substantially to municipal solid waste, often ending up in landfills where it decomposes inefficiently. Conventional disposal through burning or dumping generates pollution and greenhouse gases. Sustainable alternatives such as vermicomposting or the use of earthworms to convert organic residues into nutrient-rich compost, which offer both ecological and agricultural benefits.

The African Night crawler (*Eudrilus eugeniae*) is recognized for its efficiency in decomposing organic matter due to its high composition and reproduction rates (Lacap & Dantis, 2020). While its use with agricultural and food wastes has been extensively studied, limited research has explored its performance on paper waste substrates, particularly when combined with livestock manure. This limits the optimization of paper waste recycling through biological means.

Despite the increasing generation of paper waste and the recognized efficiency of *E. eugeniae* in organic waste decomposition, limited research has explored the potential of using various paper waste types combined with animal manure as substrates for vermicomposting. The lack of empirical data on how these substrate combinations affect the growth, reproduction, and composting efficiency of *E. eugeniae* constrains the optimization of vermicomposting systems for waste recycling. Hence, this study aimed to evaluate the effects of different paper waste substrates mixed with manure on the growth and reproductive performance of *E. eugeniae*, determine the resulting vermicompost yield and nutrient composition, and identify the most effective substrate combination that promotes optimal worm performance and compost quality.

Methods

This experimental study was laid out in a Completely Randomized Design (CRD) with six treatments replicated four times and a ratio of 1:2 kilogram paper-to-manure ratio to investigate the substrate combination most preferred by the *E. eugeniae*. The treatment was as follows:

T1 - Clean bond paper and Swine Manure (*control*)
T2 - Used bond paper and cow manure
T3 - Used notebook and cow manure
T4 - Carton and cow manure
T5 - Newspaper and cow manure
T6 - Carton, used bond paper and cow manure

Preparation of feeding material

The four kilograms of sieved manure and four kilograms of shredded waste papers, with a total of eight kilograms, were mixed and divided equally into four, equivalent to two kilograms of substrate per replication.

The study was conducted for 30 days in a nursery under room temperature conditions. The substrates were mixed weekly, and moisture levels were maintained through periodic watering as needed.

Data Collection and Analysis

All collected parameters were organized into data tables, and their totals and means were computed. The data were analyzed using Analysis of Variance (ANOVA) under a Completely Randomized Design (CRD) to determine significant differences among treatments. The

statistical analysis was performed using the STAR software, and treatment means were compared using Tukey's Honest Significant Difference (HSD) test at the 5% level of significance.

Nutrient Analysis

The nutrient analysis of the vermicompost focused on determining the macronutrient contents of nitrogen (N), phosphorus (P), and potassium (K) using standard laboratory procedures. The analytical methods followed the protocols outlined in the Bureau of Soils and Water Management (BSWM) Test Methods Manual (2022). Total nitrogen was analyzed using the Kjeldahl method, available phosphorus was determined through the Vanadomolybdate method, and exchangeable potassium was measured using flame atomic emission spectroscopy.

Result and Discussion

Wastepaper is a major concern in solid waste management due to increasing volume and environmental impact. To address this issue, the present study investigated the use of different types of wastepaper combined with cow manure and swine manure (served as control) as feeding materials for *E. eugeniae*. The primary aim was to determine the most effective substrate for the growth and productivity of *E. eugeniae.* The evaluation was based on the following parameters: *E. eugeniae* number, number of eggs, weight of mature *E. eugeniae*, weight of vermicompost, weight of unconsumed substrates and percent recovery. In addition, to assess the quality of vermicompost produce, macronutrient (NPK) content was analyzed.

Table I shows the result of the Analysis of the Variance (ANOVA) on different feeding substrates resulting in a significant effect on the number of *E. eugeniae*, number of eggs, weight of mature *E. eugeniae*, weight of vermicompost, weight of unconsumed substrates and percent recovery across treatments.

Table I. Analysis of Variance for various parameters.

PARAMETERS	FC	CV%
Number of *E. eugeniae*	0.0000**	12.26
Number of eggs	0.0001**	38.81
Weight of *E. eugeniae*	0.4338ns	17.93
Weight of vermicompost	0.0000**	12.26
Weight of unconsumed substrates	0.0000**	35.73
Percent recovery	0.0000**	12.26

ns - not significant ** - highly significant

Number of Eudrilus eugeniae

The analysis of variance indicated a highly significant effect of treatments on the number of African night crawlers, $F(5, 18) = 29.21$, $p < .001$, Tukey's HSD test ($\alpha = 0.05$) showed that T4 (carton + cow manure), T5 (newspaper + cow manure), and T6 (carton + used bond paper + cow manure) produced significantly higher worm counts than the control. The highest mean number of *E. eugeniae* was recorded in T5 (808.00), while the lowest was in T1 (112.25).

These results indicate that cow manure combined with paper wastes significantly enhances *E. eugeniae* growth and proliferation. The superior performance of T4 and T5 can be attributed to the nutrient-rich and decomposable nature of cow manure, consistent with previous studies (Castañeto & Castañeto, 2016; Kabi et al., 2020; Vyas et al., 2022), which emphasized the positive effect of organic substrate quality on worm productivity and vermicompost efficiency.

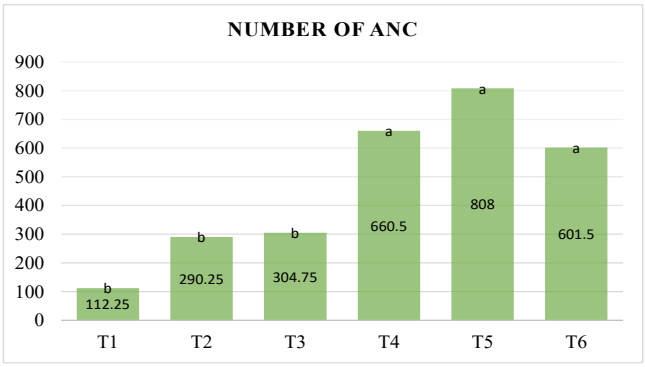

Figure I. Mean number of E. eugeniae across treatments.

Number of eggs

Figure II illustrates the significant effect of different combinations of wastepaper fed on *E. eugeniae* on the mean number of eggs. The statistical analysis (ANOVA) revealed that the number of eggs produced by *E. eugeniae* differed significantly among treatments ($F(5,18) = 10.63$, $p = 0.0001$), indicating that substrate type strongly influences reproductive output. The mean number of eggs ranged from 8.25 in the control (T1: clean bond paper + swine manure) to 486 in T4 (carton + cow manure). Tukey's HSD test showed that T4 produced significantly more eggs than T1 and T3, while cow manure–based treatments (T2, T5, T6) also showed relatively high egg counts (257–359.75), not significantly different from T4, but all were significantly higher than the control.

Cow manure–based substrates significantly enhanced the reproduction of *E. eugeniae*, with the highest egg production observed in T4 (486 eggs). Other cow manure–paper combinations (T2, T5, T6) also supported high reproductive output, whereas the control (T1) produced very few eggs (8.25), likely due to lower nutrient availability or the presence of inhibitory compounds. These findings align with Raza et al. (2020), who reported that pig manure can contain elevated salts, heavy metals, antibiotics, and ammoniacal nitrogen, which negatively affect earthworm survival and reproduction. Overall, the results emphasize that substrate composition, particularly nutrient-rich cow manure combinations, is a crucial factor in promoting worm reproduction and enhancing vermicomposting efficiency.

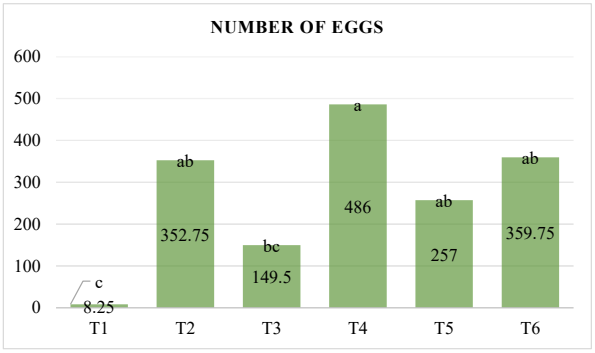

Figure II. Mean number of E. eugeniae's egg across treatments.

Weight of Eudrilus eugeniae

ANOVA results for the weight of *E. eugeniae* showed no significant differences among treatments ($F(5,18) = 1.02$, $p = 0.434$), indicating that the type of substrate whether cow manure combined with various paper wastes or swine manure did not significantly affect worm biomass. The mean weights ranged from 95.25 g in T1 (clean bond paper + swine manure) to 119.00 g in T6 (carton + used bond paper + cow manure), but Tukey's HSD would not indicate

any statistically significant pairwise differences.

Although individual worm weight did not differ significantly among treatments, contrasting results have been reported by Castaneto and Castaneto (2016), where *E. eugeniae* fed with carton showed the highest weight gain. Similarly, Basheer and Agrawal (2013) found that using shredded office waste paper combined with cow dung increased *E. eugeniae* body weight. In the present study, cow manure–based substrates, particularly T4 and T6, showed a trend toward higher biomass, aligning with increased worm numbers and more efficient substrate utilization. This indicates that worm population growth and substrate conversion may be more sensitive indicators of substrate suitability than individual worm weight, further supporting the effectiveness of cow manure–paper combinations in vermicomposting, consistent with previous findings.

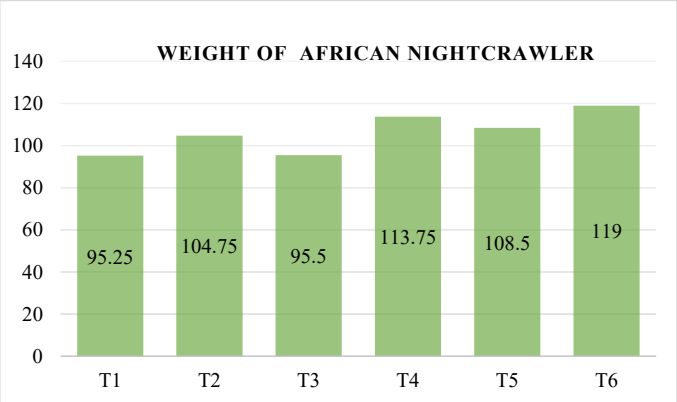

Figure III. Mean weight of African night crawler (E. eugeniae).

Vermicast yield and unconsumed substrates

The data presented in table II illustrates the influence of different organic substrates on the vermicompost production of *E. eugeniae*. Analysis of variance revealed highly significant differences among treatments for both vermicast yield and unconsumed substrate ($p < .001$). Treatments combining cow manure with wastepaper (T2–T6) produced significantly higher vermicast than the control, with the highest yield observed in T4 (1,925 g) and T2 (1,912.5 g), while the control yielded only 375 g. Tukey's HSD test confirmed that all cow manure–based treatments were statistically similar and significantly greater than the control. In contrast, unconsumed substrate was highest in the control (T1 = 1,850 g), whereas all cow manure–paper treatments had markedly lower residue (T4 = 187.5 g; T6 = 450 g), indicating more efficient substrate utilization, with T1 significantly different from all other treatments.

Cow manure combined with paper waste significantly improves vermicast production and substrate decomposition, providing nutrients and a favorable environment for *E. eugeniae*. In contrast, the swine manure control (T1) yielded low vermicast and high unconsumed substrate. Treatments such as carton + cow manure and used bond paper + cow manure were the most effective, highlighting cow manure–paper combinations as sustainable substrates for efficient vermicomposting and nutrient-rich compost production.

Table II. Weight of vermicompost and weight of unconsumed substrates

TREATMENTS	Mean Weight of vermicast yield (g)	Mean Weight of Unconsumed substrates (g)
T1 - Clean bond paper and swine manure (*control*)	375.00 [b]	1850.00 [a]
T2 - Used bond paper and cow manure	1912.50 [a]	625.00 [b]

TREATMENTS	Mean Weight of vermicast yield (g)	Mean Weight of Unconsumed substrates (g)
T3 - Used notebook and cow manure	1700.00 [a]	500.00 [b]
T4 - Carton and cow manure	1925.00 [a]	187.50 [b]
T5 - Newspaper and cow manure	1525.00 [a]	500.00 [b]
T6 - Carton and used bond paper and cow manure	1750.00 [a]	450.00 [b]

Percent recovery

Significant result of the Analysis of the Variance was obtained in the percent recovery in the vermicomposting process. As shown in Figure IV the percent recovery varies among the different treatments. Treatment 1, which used clean bond paper and swine manure, showed the lowest recovery at 18.75% and was significantly different from all other treatments. In contrast, all treatments containing cow manure demonstrated significantly higher recovery rates, ranging from 76.2% to 96.25%, indicating better survival and decomposition/digestion, and preference of *E. eugeniae* in cow manure-based substrates. Among these, T4 (carton and cow manure) had the highest percent recovery at 96.25%, closely followed by T2 (used bond paper and cow manure) with 95.62%.

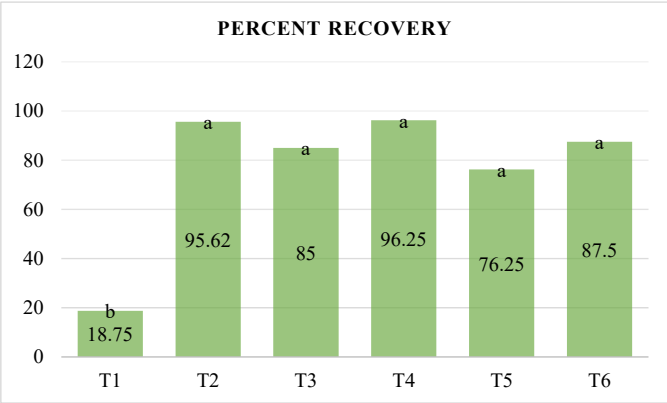

Figure IV. Percent recovery of different wastepaper fed to African night crawler.

Nutrient Profile

The nutrient profile of the vermicompost produced from different wastepaper treatments reveals significant variations in macronutrient content, which directly reflects the effectiveness of each substrate in supporting the growth of *E. eugeniae* and the quality of the resulting compost. Among the nutrients measured were the total Nitrogen (N), Available Phosphorus (P), and Exchangeable Potassium (K). Nitrogen is the most critical for evaluating compost maturity and fertility. The treatment that combined carton and cow manure (T4) yielded the highest total nitrogen content at 2.10%, indicating optimal organic matter decomposition and microbial activity. This was followed by T3 (used notebook and cow manure) and T2 (used bond paper and (T5 (used bond paper/newspaper with cow manure), which also recorded relatively high nitrogen levels. In contrast, the control treatment (T1: clean bond paper and swine manure) and T6 (carton, used bond paper, and cow manure) had the lowest nitrogen levels at 1.05%, suggesting less efficient composting.

Interestingly, while T1 showed the highest phosphorus (1.36%) and potassium (0.001829%) contents, it also had the poorest vermicompost output and the largest amount of unconsumed substrate. This implies that the nutrients may not have been fully processed or assimilated due to suboptimal worm activity in this treatment. In comparison, the cow manure-based treatments, though slightly lower in phosphorus and potassium, demonstrated more balanced nutrient profiles and better

overall composting performance. These findings are consistent with previous research, such as studies by Kumar and Shweta (2011) and Suthar (2007), which highlighted cow manure's superior suitability for vermicomposting due to its favorable C:N ratio and digestibility. Furthermore, Ro et al. (2022) noted that cow manure combined with agricultural waste produces vermicast richer in nitrogen and better in texture, making it ideal for soil amendment.

Table III. Macronutrient analysis of the Vermicompost

Treatments	Macronutrient Content		
	Total Nitrogen (%)	Available Phosphorus (%)	Exchangeable Potassium (%)
T1 - Clean bond paper and swine manure	1.05	1.36	0.001829
T2 - Use bond paper and cow manure	1.57	0.442	0.000162
T3 - Used notebook and cow manure	1.75	0.452	0.000168
T4 - Carton and cow manure	2.1	0.449	0.000181
T5 - Newspaper and cow manure	1.57	0.415	0.000177
T6 - Carton and used bond paper and cow manure	1.05	0.447	0.000225

The nutrient profile analysis supports the conclusion that cow manure, when used in combination with biodegradable paper waste, enhances both the quantity and quality of vermicast. Treatments like T4 not only yielded the highest vermicast weight but also exhibited the most favorable nutrient composition, making them the most effective substrates for promoting the growth of *E. eugeniae* and producing high-quality vermicompost.

Conclusion

Substrate composition significantly influenced the vermicomposting performance of *Eudrilus eugeniae*. The combination of carton and cow manure produced the highest vermicast yield, recovery rate, and nitrogen content, while the control treatment (swine manure) performed least effectively.

This study demonstrates the potential of cow manure mixed with waste paper as a sustainable substrate for vermicomposting. It offers practical applications for managing paper and livestock waste while generating organic fertilizer for agricultural use.

This study was conducted under controlled conditions and a limited duration. Future studies should explore large-scale applications, varying environmental conditions, and microbial analysis to enhance understanding of substrate-worm interactions.

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