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Vermicomposting for Degradation of Cotton using African Night Crawler Worm

Ahmad Fakhri Hakim Nor Radi[a], Teo Chee Loong[b], Zarita Zakaria[a] and Nor Azimah Mohd Zain[a]*

[a] Department of Biosciences, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia.
[b] Agri Season Sdn Bhd, 81900 Kota Tinggi, Johor, Malaysia

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*Corresponding author
norazimah@utm.my

Abstract

The fashion industry generates vast amounts of cotton waste, posing a major environmental challenge. Vermicomposting using the African Night Crawler (ANC) (*Eudrilus eugeniae*) worm offers a sustainable solution for recycling textile residues. This study evaluated the effectiveness of ANC worms in decomposing cotton under varying worm density, moisture, and composting duration. The resulting vermicompost and vermitea were analyzed for nutrient content, glucose levels, and carbon-to-nitrogen (C/N) ratio, while structural changes in cotton fibres were examined using Field Emission Scanning Electron Microscopy (FESEM). Results showed that higher worm populations, optimal moisture (60–80%), and longer composting periods promoted complete cotton degradation and nutrient enrichment. FESEM images revealed extensive fibre breakdown, confirming effective bioconversion. Overall, ANC-based vermicomposting demonstrates strong potential for managing cotton waste and producing nutrient-rich organic fertilizer for sustainable agriculture.

Keywords: Vermicomposting, African Night Crawler Worm (ANC), Cotton degradation, Waste management

1.0 INTRODUCTION

Cotton, a natural and renewable fibre, remains central to the global fashion industry due to its comfort and versatility. However, the rapid growth of fashion, driven by consumer demand for inexpensive and frequently changing styles, has intensified the accumulation of cotton-based textile waste. The frequent disposal of clothing has created a serious environmental challenge, as cotton waste contributes substantially to solid waste generation and landfill burden [1]. Among available management strategies, vermicomposting has emerged as an environmentally sustainable and low-cost method for recycling organic residues, including cotton waste [2,3]. In this process, earthworms biologically decompose organic matter, producing a nutrient-rich material known as vermicompost, which enhances soil structure, nutrient availability, and microbial activity [4].

The African Night Crawler (ANC) (*Eudrilus eugeniae*) worm is particularly effective for textile biodegradation due to its high feeding rate, tolerance to varying conditions, and diverse digestive enzyme system. Its gut secretes cellulase, amylase, invertase, protease, and phosphatase, which catalyze the breakdown of cellulose, starch, and protein components of natural fabrics [5, 6, 7, 8]. A previous study showed that *E. eugeniae* can degrade cotton and other biodegradable textiles, such as linen and silk, within 60–90 days under optimal conditions [9].

Key physicochemical parameters that influence vermicomposting efficiency are moisture content between 60 to 80% and pH between 6.0 and 8.5, which support optimal worm activity and microbial synergy. At the same time, deviations may lead to stress, anaerobiosis, or nutrient loss [10, 11, 12]. Similarly, maintaining a carbon-to-nitrogen (C/N) ratio of 20:2 to 30:1 is crucial; higher ratios slow decomposition, whereas lower ratios can increase ammonia toxicity [13, 14].

In this study, we investigate the effectiveness of *E. eugeniae* in degrading cotton waste under varying conditions of worm population, moisture content, and composting duration. The physicochemical characteristics of the resulting vermicompost and vermitea, particularly nitrogen (N), phosphorus (P), potassium (K), glucose, and C/N ratio, were analyzed, alongside microstructural changes in the cotton fibres using Field Emission Scanning Electron Microscopy (FESEM). The findings aim to establish the potential of ANC-mediated vermicomposting as a sustainable biotechnological approach for the valorization of cotton waste and nutrient recovery.

2.0 EXPERIMENTAL

2.1 Vermicomposting System

A vermicomposting system, including 7 vermireactors and a vermibed, was set up. The 7 vermireactors (L50 cm x W33 cm x H29 cm) were labelled with Control, A1, A2, B1, B2, C1, and C2. For the vermibed, 1.25 kg of cotton waste, 1 kg of cow manure, 0.25 kg of empty fruit bunch (EFB), and 4.5 L of water were placed in each vermireactor. The cotton waste was then shredded into small pieces to increase the surface area and facilitate decomposition [15].

2.2 Experimental Design

The experiment used a randomized design with three treatments and two levels per treatment, as shown in Table 1. All 7 vermireactors were maintained at 28°C (±2.0). Their humidity was maintained at ~75% of field capacity by adding water as needed, except for B2 and B3. Each vermireactor, except for A1 and A2, was inoculated with 30 adults of *E. eugeniea* (ANC). The vermicomposting period was set at 90 days for C1 and 30 days for C2.

Table 1: Experimental design.

Treatment Factor	Vermireactor	Value
Amount ANC worm	A1	15 worms
	A2	45 worms
Moisture content	B1	60%
	B2	80%
Days of composting	C1	30 days
	C2	90 days

2.3 Monitoring Data and Sample Collection

The vermicompost was monitored every week until day 90. The moisture content of vermicompost in all vermireactors was checked weekly and adjusted as needed to maintain it. Maintaining the correct moisture level is crucial for the success of vermicomposting, as it affects microbial activity and the well-being of the composting worms [16]. Temperature and pH levels were also recorded. Samples of vermitea were collected weekly using a sampling bottle for all treatments. After 90 days of vermicomposting, the vermicompost and worms were separated from the remaining cotton sample and placed in a container. All samples, including vermicompost, cotton, and vermitea, were collected and stored for further analysis. The cotton sample was checked to ensure there was no compost residue or worms left on it. After that, the remaining cotton was dried in the sunlight for 48 hours, weighed, and recorded to calculate the rate of decomposition, and the percentage decomposition was calculated using equations [17].

$$\text{Rate decomposition of cotton (g/day)} = \frac{(Wo - Wt)}{T}$$

$$\text{Percentage decomposition of cotton (\%)} = \frac{(Wo - Wt)}{T} \times 100$$

Reference:
Wo = Initial cotton weight (g)
Wt = Weight after composting process at T-time (g)
T = Composting time (days)

2.4 Analysis of Nutrient Content in Vermicompost using Soil Nutrient Concentration Sensors

A soil nutrient concentration sensor was inserted into the vermicompost sample for nutrient content analysis. Sensors were properly positioned within the vermicompost. The soil nutrient concentration sensor provided readings on nitrogen, phosphorus, and potassium concentrations [18].

2.5 Analysis of Carbon-to-Nitrogen Ratio in Vermicomposting using Elemental Analyzer

For carbon-to-nitrogen analysis, 5 mg of a compost sample was weighed, then placed into a silver capsule used to hold the sample during combustion. After that, the elemental was calibrated using appropriate standards for carbon and nitrogen. The sample was then introduced into the combustion chamber of the elemental analyzer. Detectors measured the released gases. The C:N ratio was calculated from the carbon and nitrogen contents determined by the elemental analyzer [19].

2.6 Analysis of Glucose Content in Vermitea using Dinitrosalicylic (DNS) Colourimetric Method

For glucose content analysis in a vermitea sample, the DNS reagent was prepared by dissolving 1 g of DNS in 20 mL of 2 M NaOH. 30 g of sodium potassium tartrate was dissolved in about 50 ml of distilled water. After that, both solutions were combined and diluted to 100 mL with distilled water. A series of glucose standard solutions at 10, 20, 30, 40, and 50 mg/mL was prepared from a 1000 mg/L glucose stock solution. The vermitea sample was prepared by pouring 5 ml of vermitea into a measuring cylinder, filtering it into a 100 ml volumetric flask, and adding distilled water to 100 ml. 10 ml of the diluted vermitea sample was then diluted with distilled water in a 100 ml volumetric flask and mixed well. After that, 1 ml of each glucose standard solution was pipetted into labelled test tubes. 1 ml of the vermitea sample was pipetted into a test tube and labelled as "vermitea". Then, 1 ml of DNS reagent and 3 ml of distilled water were pipetted into each test tube. All the test tubes were arranged in a rack and placed in a boiling water bath at 100°C for 5 minutes to allow the reaction to proceed [20]. After 5 minutes, the test tubes were transferred to a container of iced water to stop the reaction, then allowed to stand at room temperature for 10 minutes. The samples in each test tube were transferred into cuvettes. The absorbance was measured with a single-beam spectrophotometer at 540 nm, and a glucose standard curve was generated.

2.7 Analysis of Degraded Cotton Structure using Field Emission Scanning Electron Microscope (FESEM) Analysis

For cotton structure analysis, the undegraded and degraded cotton samples were cut into small pieces, ensuring they were clean and free from contaminants. The cotton samples were fixed to a stub or holder using double-sided adhesive carbon tape and properly grounded to prevent charging artifacts. Subsequently, the cotton samples were coated using an Automated Platinum Sputter Coater to stabilize their structure and prevent further changes during analysis [21]. The sample holder with the cotton samples was placed into the FESEM chamber, and a good vacuum was established to prevent electron scattering. The FESEM was set to the desired acceleration voltage of 2.0 kV. The working distance and aperture settings were also adjusted to optimize imaging. High-resolution images were captured at various magnifications to examine the cotton's surface structure.

3.0 RESULTS AND DISCUSSION

3.1 Assessment of the Efficacy of Vermicomposting in Cotton Degradation

Figures 1 and 2 display significant differences in vermicompost before and after the vermicomposting process. Vermireactors A2, B1, B2, and C2 in Figure 1 show that no cotton remains in the vermicompost compared to A1 and C1. This suggests that the cotton has been successfully degraded through vermicomposting. Factors such as the substantial number of ANC worms (45 in vermireactor A2 compared to 15 in vermireactor A1) have accelerated the degradation of cotton, leading to its complete degradation. Although cotton decomposition rates at 60% and 80% moisture were comparable, both conditions yielded complete degradation, indicating that moisture within this optimal range facilitates worm and microbial activity without being rate-limiting. Thus, rather than acting as a direct determinant of decomposition rate, moisture functions as a regulatory parameter that maintains suitable environmental conditions for efficient vermicomposting. Vermireactor C1, allocated 30 days, failed to fully degrade the cotton into vermicompost, whereas Vermireactor C2, allocated 90 days, did.

Figure 1 : Images of vermicompost before the vermicomposting process.

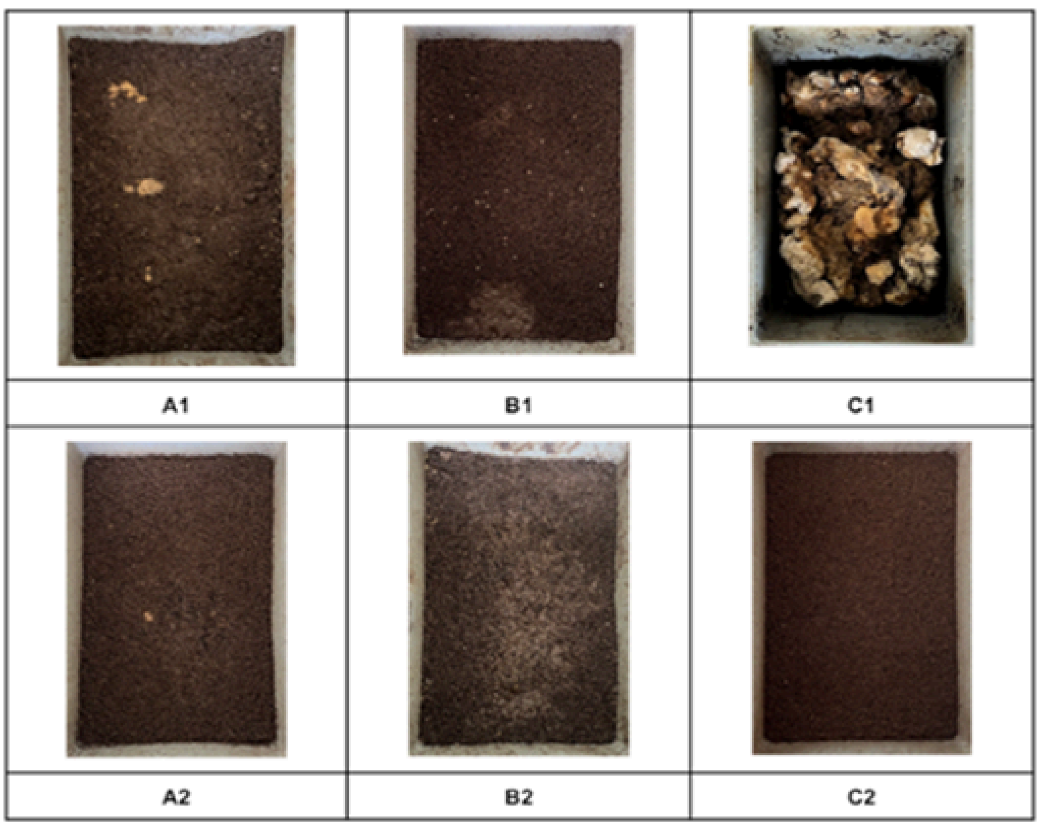


Figure 2 : Images of vermicompost after the vermicomposting process.

Figure 3 shows the decomposition rate graph of cotton in vermicompost for each vermireactor. The decomposition rate of cotton is calculated by dividing the weight of lost cotton (in kilograms) by the number of vermicomposting days. Cotton in vermireactors A2, B1, B2, and C2 exhibits the highest decomposition rate at 0.0139 g/day, compared to the control at 0.0004 g/day, A1 at 0.0123 g/day, and C1 at 0.0107 g/day, respectively. The decomposition rate of cotton is lower in vermireactor A1 compared to the others due to the limited number of worms in the vermireactor, which is only 15. This slower decomposition process of cotton is a result of the lower worm population. In vermireactor C1, the cotton in vermicompost displays the lowest decomposition rate at 0.0107 g/day, as this vermireactor was allocated only 30 days for the vermicomposting process. Within this timeframe, the ANC worms may still be adapting to the new vermicompost environment, indirectly causing a slight slowdown in the rate of cotton decomposition.

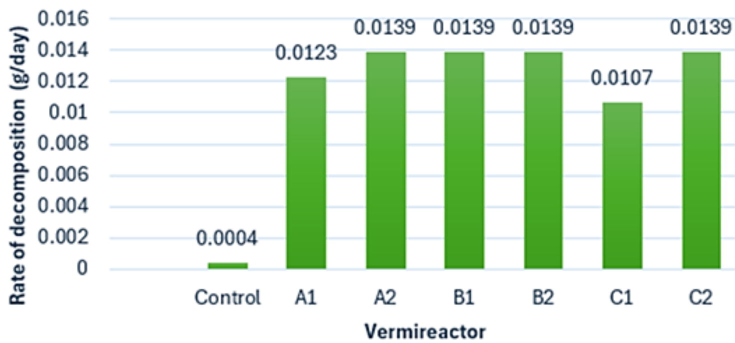


Figure 3 : Graph rate decomposition of cotton.

The percentage of cotton decomposition in vermicompost is calculated by dividing the loss of cotton weight by the initial weight of cotton, then multiplying by 100. According to Figure 4, which illustrates the percentage decomposition of cotton, cotton in vermireactors A2, B1, B2, and C2 exhibits the highest percentage decomposition, reaching 100% compared to the control at 3.2%, A1 at 88.8%, and C1 at 88.8%. This indicates that the presence of many ANC worms, moisture content levels between 60% to 80%, and an adequate composting period of 90 days have all contributed to the successful decomposition of cotton in the vermicompost. The control group shows the lowest cotton decomposition rate at 3.2%. Although the control lacks ANC worms, minimal decomposition could still occur, possibly due to microbial activity present in the control.

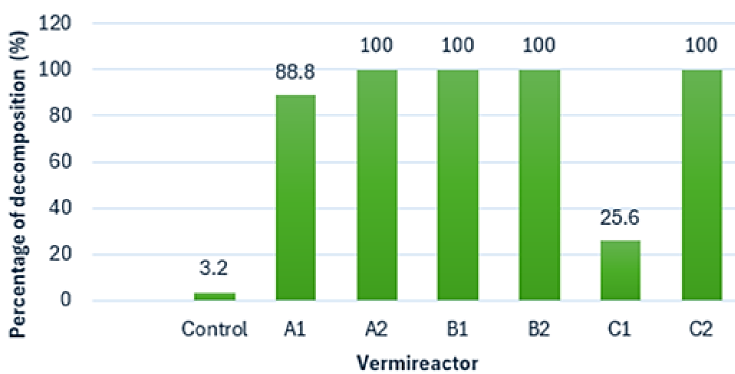


Figure 4: Graph percentage decomposition of cotton.

To probe the sources of variability across treatments, we compared pairs that isolate single factors. Increasing *E. eugeniae* from 15 (A1) to 45 individuals (A2) raised the reactor-level decomposition rate from 0.0123 to 0.0139 g day^{-1}, normalized per worm. This suggests diminishing returns ($\approx 8.2\times10^{-4}$ vs $\approx 3.1\times10^{-4}$ g $worm^{-1}$ day^{-1}), consistent with density-dependent access to cotton fibres (as shown in Figure 3). Moisture at 60% (B1) vs 80% (B2) yielded the same maximal rate (0.0139 g day^{-1}) and 100% decomposition, indicating moisture was not rate-limiting within the 60 to 80% operational window. By contrast, extending the composting period from 30 (C1) to 90 (C3) days increased the rate (from 0.0107 to 0.0139 g day^{-1}). It enabled complete substrate loss, underscoring duration as a primary driver for highly cellulosic feedstocks. Together, these comparisons suggest that maximal performance emerges from sufficient worm population and time, with moisture acting as an enabling condition within the recommended range rather than an amplifier of decomposition under our settings.

3.2 Temperature Variations in Vermicompost Throughout the Vermicomposting Process

For temperature variation in vermicompost throughout the vermicomposting process, the graph in Figure 5 shows that the control temperature pattern showed no significant difference, fluctuating slightly between 28°C and 29°C. The vermicompost in the vermireactors A2 and C2 has the highest temperature, 32°C, in Week 13. An increase in temperature enabled the thermophilic stage, which was mostly influenced by worm activity. These changes in the psychochemical characteristics of composting material enabled the decomposition of hemicelluloses, cellulose, and lignin [20]. The temperature pattern in the vermicompost showed a slight increase across all vermicompost reactors from Week 1 to Week 5, followed by a decrease from Week 6 to Week 9 and an increase again from Week 10 to Week 13. Since the vermicompost was placed outside the T02 building, environmental factors, such as weather, also affect its temperature. The vermicomposting process, which takes place from the beginning of December 2023 to the beginning of March 2024, coincides with the northeast monsoon season. Consequently, the high rainfall during this period may have contributed to a more humid environment, potentially leading to a decrease in vermicompost temperature [22].

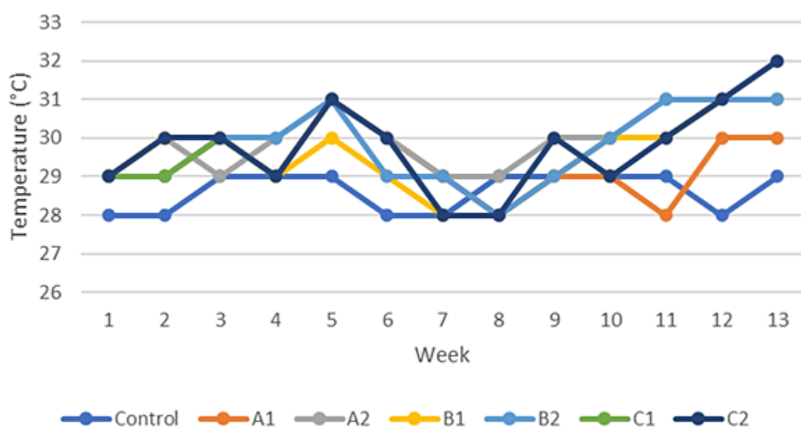


Figure 5 : Temperature in vermicompost.

3.3 pH Variations in Vermicompost Throughout the Vermicomposting Process

A soil pH tester was used to test the pH for each vermicompost in all the vermireactors. According to the study, the pH range used for the composting process was 6.8 to 7.7. Based on Figure 6, the pH of vermicompost increases from Week 1 to Week 13. The pH has increased, indicating that the cotton inside the vermicompost has begun to decompose. Compared with the control, the pH of vermicompost in vermireactors A1 and B2 reached neutrality earlier, at 7.0 in Week 4. The pH pattern in the control showed no significant change; it fluctuated slightly, ranging from 6.8 to 6.9. The pH pattern shows a slight decline in vermireactor A1 and B2 during Week 10, and in vermireactor C2 during Week 7. After Week 10, all vermireactors showed an increase in pH until Week 13. The production of carbon dioxide gas and organic acids during the decomposition of cotton and empty fruit bunches may be responsible for a decrease in pH [23].

3.4 Nutrient Content Alterations Pre- and Post-Vermicomposting Process

A soil nutrient concentration sensor was used to measure nutrient concentrations in vermicompost before and after the vermicomposting process. The nutrient content of nitrogen, phosphorus, and potassium in vermicompost increased significantly after vermicomposting. Figure 7 shows graphs of the nutrient concentrations of Nitrogen (N), Phosphorus (P), and Potassium (K) in vermicompost. Before vermicomposting, the initial nutrient concentrations of nitrogen, phosphorus, and potassium in the organic materials (cotton, empty fruit bunches, and cow dung) are relatively lower than after the vermicomposting process is completed. As cotton and other organic matter decompose under the ANC worm during vermicomposting, nutrient concentrations increase substantially. This increase is primarily due to the breakdown of organic matter by the ANC worm, which releases essential nutrients, including nitrogen, phosphorus, potassium, and micronutrients, into the vermicompost [24].

After the vermicomposting process, the concentrations of nitrogen (N), phosphorus (P), and potassium (K) in the vermicompost increased substantially compared to the initial substrate, indicating active mineralization and nutrient enrichment by *E. eugeniae*. In this study, the post-vermicomposting nutrient concentrations ranged approximately from 98 to 180 mg/kg for nitrogen, 120–210 mg/kg for phosphorus, and 334-640 mg/kg for potassium. These values were then compared with reported benchmark ranges for mature compost and vermicompost used as agricultural amendments. According to Adhikary [4] and Ali et al. [25], nutrient levels in mature compost typically fall within 0.8 to 2.0% for N, 0.3 to 0.6% for P, and 0.4 to 1.2% for K, depending on feedstock composition and process maturity. Similarly, Domínguez [10] and Punde et al. [26] reported that vermicompost of agricultural quality usually contains 1.0 to 1.5% N, 0.5 to 0.8% P, and 0.8 to 1.5% K. When normalized to comparable units, the nutrient values obtained in the present study fall within the lower to moderate range of these published standards. This outcome reflects the inherently low nitrogen content of cotton-based substrates, yet demonstrates that the vermicompost achieved substantial nutrient enhancement and chemical maturity. The enrichment of NPK elements after vermicomposting supports the conclusion that ANC-mediated bioconversion not only facilitates cotton degradation but also yields nutrient-balanced compost suitable for application as an organic soil conditioner.

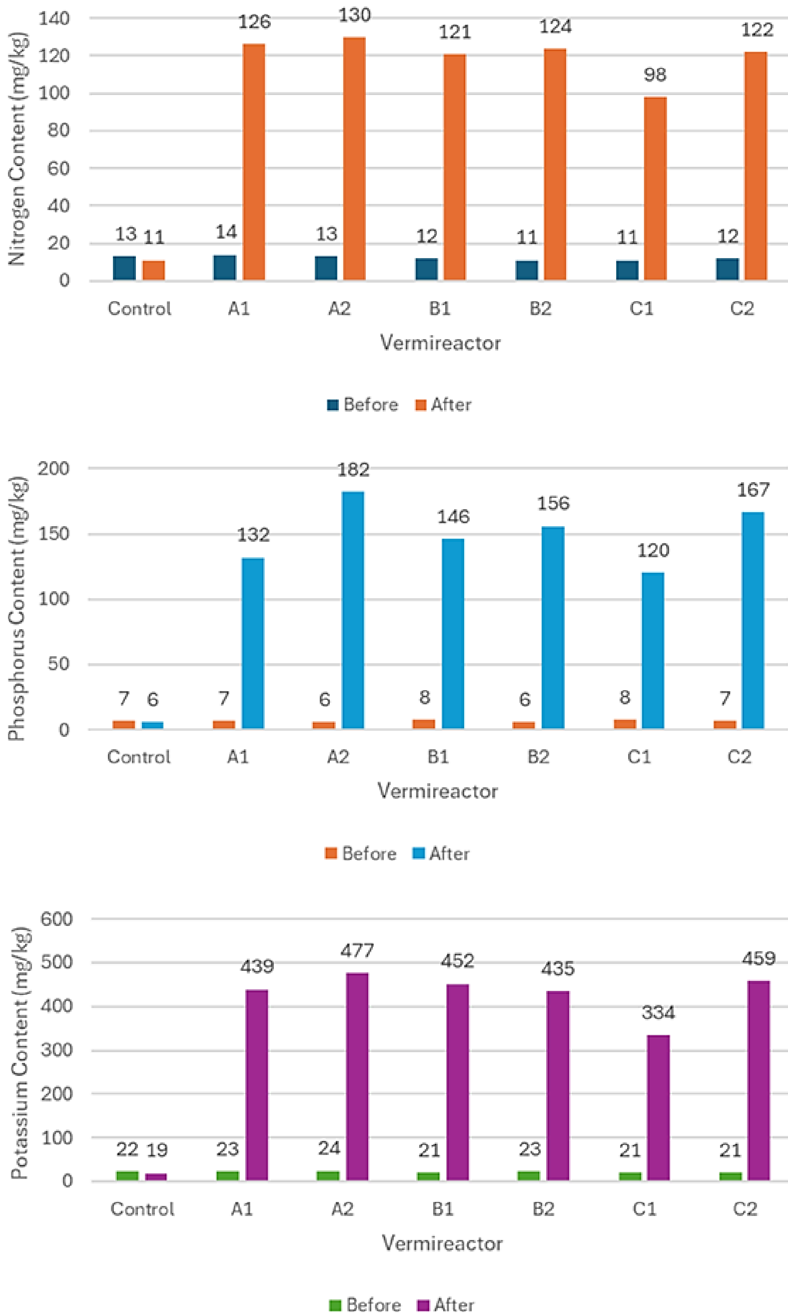


Figure 7 : Nutrient content concentration in vermicompost.

Vermireactor C1 has the lowest nutrient concentration of nitrogen, phosphorus and potassium, which are 98, 120 and 334, respectively, after the vermicomposting process is complete, compared to other vermireactors. Vermirector C1 was allocated 30 days for vermicomposting, which explains the lowest nutrient concentrations. The short time results in an incomplete vermicomposting process, and cotton and other organic materials are not fully composted. For many various solid wastes, the pre-compost phase lasts 5 to 10 days, but cotton wastes require longer periods from 20 to 25 days or more for their decomposition, followed by 90-120 days of vermicomposting, for a total of approximately 3-4 months to fully decompose cotton using this method [27].

3.5 Determination of Glucose Content in Vermitea

The dinitrosalicylic acid (DNS) method was used to determine the glucose content in the vermitea sample. The DNS colourimetric method is used to detect the presence of the carbonyl group (C=O) in reducing sugars, specifically glucose. When the DNS reagent combines with any reducing sugar, an oxidation-reduction reaction occurs, producing

3-amino-5-nitrosalicylic acid, an aromatic compound that absorbs light strongly at 540 nm. This allows for quantitative spectrophotometric assessment of the quantity of glucose present in the vermitea.

Figure 8 shows a graph of absorbance versus glucose concentration. Based on the graph, the average absorbance values for glucose standard solution concentrations of 10 mg/mL, 20 mg/mL, 30 mg/mL, 40 mg/mL, and 50 mg/mL are 0.079, 0.148, 0.319, 0.543 and 0.579, respectively. From the data, we could observe that the higher the concentration of the glucose standard solution, the higher the average absorbance. Thus, we could conclude that the glucose standard solution concentration is directly proportional to the average absorbance. For the determination of glucose in a vermitea sample, a linear standard curve was used, yielding the equation $y = 0.0127x – 0.0404$. The average absorbance of the vermitea sample is 0.075. The concentration of glucose in the vermitea sample was calculated by substituting the average absorbance into the equation derived from the curve. The calculated concentration of glucose in the vermitea sample is 9.1260 mg/mL. The main component for vermicomposting is cotton, which ANC digests to produce glucose. However, the glucose concentration in the vermitea sample is relatively low at 9.1260 mg/mL. The low glucose concentration in vermitea samples may result from the consumption of glucose by the ANC worms and other microbes present in the vermicompost as their primary energy source [28]. The worms and microbes break down glucose into simpler compounds, which are then used in their metabolic processes, thereby reducing the overall glucose concentration in the vermicompost [29].

The detected glucose concentration in the vermitea (9.1260 mg/mL) likely reflects the complex interplay between enzymatic hydrolysis of cotton cellulose and microbial metabolism within the vermicomposting system. The *E. eugeniae* secretes digestive enzymes, including cellulase, amylase, and invertase, that depolymerize the cellulose and hemicellulose components of cotton fibres into simpler reducing sugars such as glucose [7,8]. This enzymatic activity releases soluble carbon compounds into the vermitea, providing an immediate energy source for resident microbial populations. Microorganisms in the vermicompost, particularly bacteria and fungi, further utilize this glucose for respiration and growth, converting it into microbial biomass and low-molecular-weight metabolites such as organic acids and CO_2 [28, 29]. The observed glucose concentration at day 90, therefore, represents a dynamic equilibrium between the continuous enzymatic release of sugars from cotton degradation and microbial assimilation of these intermediates. The relatively moderate residual glucose level indicates an efficient and balanced microbial-worm synergism, supporting stable nutrient cycling and compost maturity.

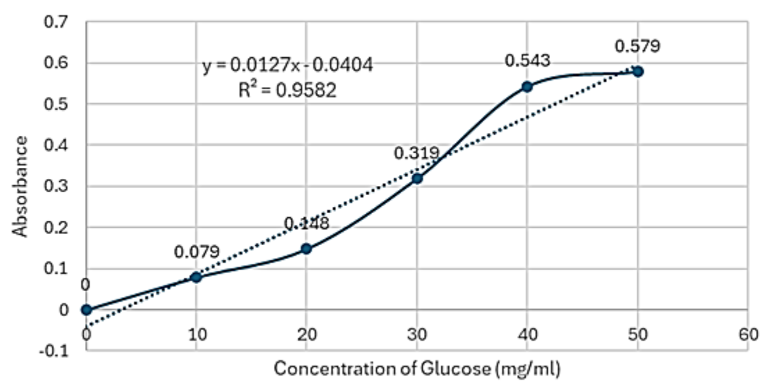


Figure 8 : Absorbance against concentration of glucose.

3.6 Determination of Carbon-to-Nitrogen Ratio in Vermicompost

The elemental analyzer was used to determine the carbon and nitrogen percentages in the vermicompost sample, as shown in Figure 9. The C/N ratio was determined using the percentage of carbon and nitrogen in the vermicompost. The graph shows changes in the C/N ratio during vermicomposting over 90 days. Initially, during the first 30 days, the C/N ratio was around 22.7:1.8, which is considered a suitable range for efficient composting. During the vermicomposting process, the C/N ratio gradually increased to 23.6:1.9 on day 60, then decreased to approximately 19:1 by the end of the 90-day period.

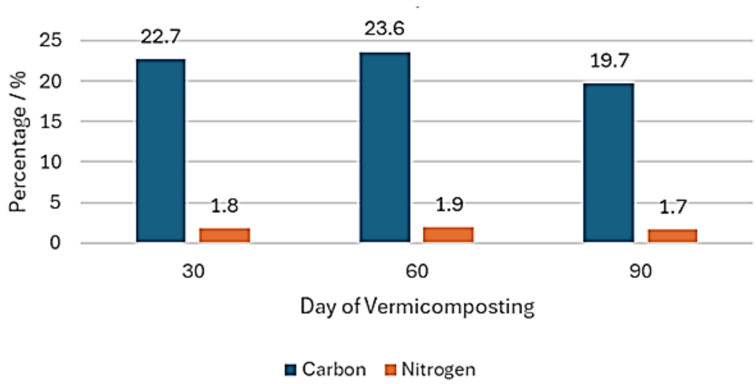
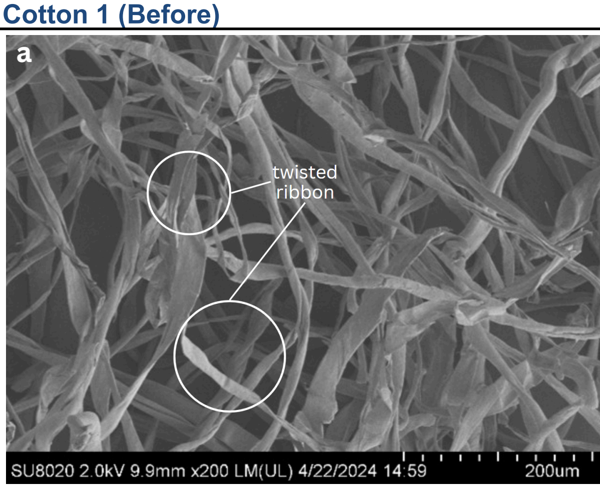
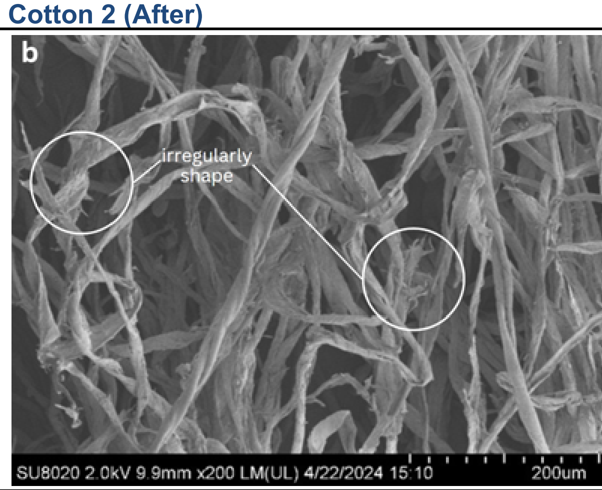


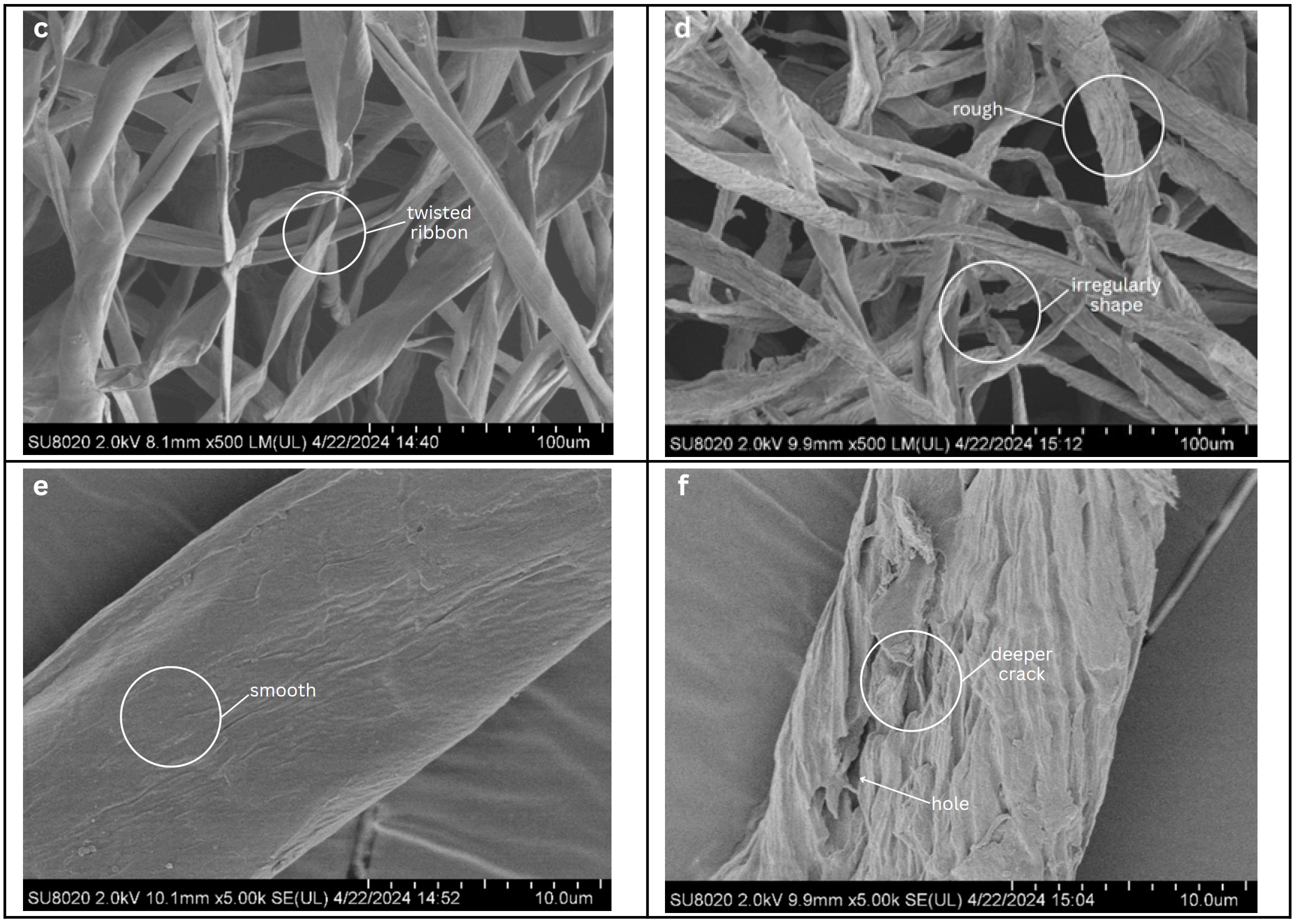
Figure 9 : Percentage of carbon and nitrogen in vermicompost.

The decrease in C/N ratio can be attributed to the decomposition of organic matter by the ANC worm and microorganisms involved in the vermicomposting process. During this process, carbon serves as an energy source, while nitrogen is essential for the growth and reproduction of these organisms [31, 3]. As a result, carbon content decreases relative to nitrogen, leading to a lower C/N ratio in the final vermicompost. A C/N ratio between 10:1 and 20:1 is considered ideal for mature compost, as it indicates a balance between carbon and nitrogen [24]. The vermicompost produced within this range is nutrient-rich and stable, making it suitable for application as a soil amendment or fertilizer. The C/N ratio of mature compost depends on the quality and characteristics of the raw organic waste used, but it is generally about 15-20:1 for good, mature compost [26].

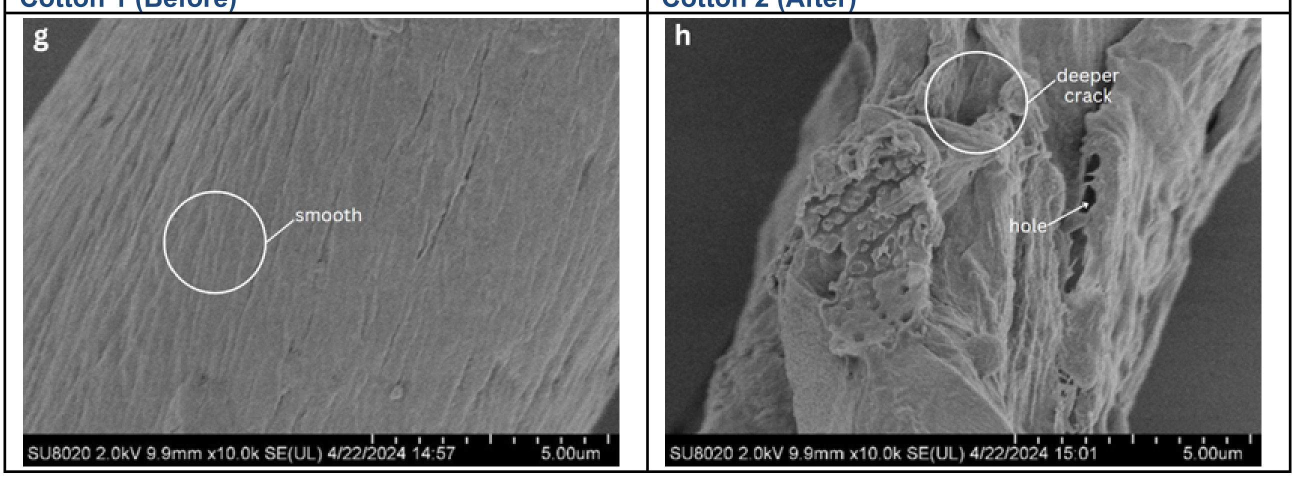
3.7 Structural Comparison of Cotton Before and After Vermicomposting

The FESEM images of the cotton samples before and after biodegradation via vermicomposting are shown in Figure 10. Cotton 1 is the original cotton that has not undergone vermicomposting, whereas Cotton 2 is the remaining cotton after the vermicomposting process is completed, obtained from Vermireactor A1. Cotton 1 (images a and c at 200x and 500x magnification) displays the distinctive structure of each fibre type, including the twist-ribbon shape of cotton fibres. In contrast, Cotton 2 (images c and d) appears to be irregularly shaped and rougher. There was clear evidence of deterioration in the surface appearance of cotton before and after biodegradation using the vermicomposting method. Cotton 1, as seen in images e and g at 5000x and 10000x magnification, shows a smooth and clean surface, while Cotton 2 images f and h display deeper and wider cracks along the cotton fibre axes and holes. Cotton 1, as shown in image i at 20,000x, exhibits a more compact, smoother surface, while Cotton 2, as shown in image j, has a more porous, rougher surface.

Cotton 1 (Before)	Cotton 2 (After)
	



Cotton 1 (Before) | **Cotton 2 (After)**



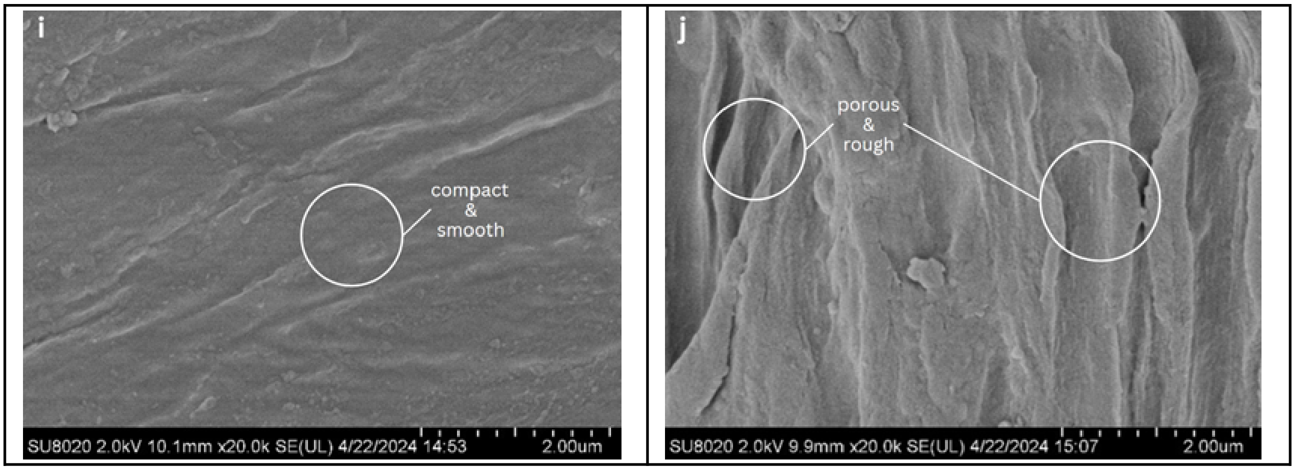


Figure 10 : FESEM images of cotton samples before (Cotton 1) and after (Cotton 2) degradation during the vermicomposting process at 200x, 500x, 5000x, 10000x and 2000.

Cotton, as a cellulosic fibre, is inherently a carbon-rich organic material, making it degradable. It has the highest cellulose content of any natural fibre, with dried cotton fibre containing 88%-96% cellulose [30]. This constituent of the cotton makes it easy for the African Night Crawler (ANC) worm to degrade it. The ANC worm consumes cotton as part of its diet. Through their digestive processes, these worms break down the organic matter, including cotton, into compost [31].

The significant structural degradation of cotton fibres observed under FESEM, characterized by widened cracks, increased surface roughness, and increased porosity, has important agronomic implications. These microstructural alterations enhance the surface area and porosity of the resulting vermicompost, properties that can improve soil aeration, aggregation, and water-holding capacity when incorporated into agricultural soils. Together with elevated nutrient content (N, P, K) and a balanced C/N ratio (~19:1), the cotton-derived vermicompost is a stable, nutrient-rich organic amendment that can improve soil fertility and microbial activity. The residual cellulose fragments and humified organic matter provide a slow-release carbon source that supports beneficial microbial biomass and enzyme activity, thereby fostering plant root growth and nutrient uptake [22, 25]. Future work will focus on controlled greenhouse and field trials to quantify these effects on soil physicochemical parameters, microbial community structure, and crop productivity. Such experiments will validate the potential of ANC-based vermicompost from cotton waste as a sustainable biofertilizer for circular agriculture.

4.0 CONCLUSION

This study showed that the African Night Crawler (ANC) (*E. eugeniae*) effectively composts cotton waste, transforming it into nutrient-rich, stable organic fertilizer. Higher worm populations and longer composting durations promoted complete cotton degradation, while maintaining moisture between 60 to 80% was essential for sustaining microbial and worm activity, even though it did not significantly alter decomposition rates. The moderate glucose concentration in vermitea (9.1260 mg/mL) and the decline in C/N ratio confirmed biological stabilization and compost maturity. FESEM analysis revealed extensive fibre fragmentation and pore formation, indicating efficient enzymatic degradation of cotton cellulose. These microstructural transformations improve soil aeration, water retention, and nutrient release when applied as an organic amendment. Overall, ANC-based vermicomposting offers a sustainable strategy for valorizing textile waste and enhancing soil fertility. Future studies should validate these findings under greenhouse and field conditions to assess their agronomic performance and long-term soil health benefits.

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